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Textbook  
of  
**PHARMACOGNOSY**



Irish Moss beds above the beach being raked over by a tedder. Town of Scituate, Mass. in background.



The Irish Moss (*Chondrus crispus*) industry at Scituate, Mass. Scene in Scituate where the red alga is being spread out in beds to be exposed to the bleaching action of

# *Textbook of* *Pharmacognosy*

*By*

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**521 Illustrations**

**Sixth Edition**

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SIXTH EDITION

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PRINTED IN THE UNITED STATES OF AMERICA

*Dedicated*

TO THE MEMORY OF MY FATHER AND MOTHER,  
CHARLES E. AND MARIAN W. YOUNGKEN .

## PUBLISHER'S NOTE

The present revision is a thorough one. However, the entire book has not been reset. The publishers preferred to insert additions, corrections, and changes. This made possible the publication of this edition in time for Fall classes in 1948. Of greater importance is the fact that savings in typesetting made it possible to keep the price of the book within a reasonable figure for the benefit of the student.

Such type changes as we have mentioned make for occasional unsightly pages. We feel that the reader's annoyance will be tempered by the significant comments made above.

## PREFACE TO THE SIXTH EDITION

Since the publication of the fifth edition, the reports of many investigations in different fields of pharmacognosy have appeared in the scientific literature; new therapeutic agents of biological origin including the antibiotics, rutin, the digitalis glycosides, piscidia, the newer hormones and insecticides of plant origin, and the various plasma fractions of human blood have appeared on the drug market; changes have occurred in a number of the commercial sources of drugs and in drug uses; and new constituents have been isolated from a number of the older natural drugs. During 1947, the Thirteenth Revision of the *United States Pharmacopœia* and the Eighth Edition of the *National Formulary* became official with numerous additions, deletions and changes in their monographs.

In the preparation of the present edition, I have endeavored to take cognizance of these advances and changes and to bring the text into conformity with the best current pharmacognostical thought and practice.

While planned primarily for the use of students in undergraduate pharmacognosy courses of colleges of pharmacy, there is included sufficient material on the characteristics, culture, harvesting, drying and storage of drug and aromatic plants and their products, on microanalytical methods, including quantitative microscopical analysis, determination of vein islet numbers, palisade ratios, stomatal indexes, etc., to make the book serviceable, in advanced courses of graduate level in pharmacognosy, to growers of medicinal plants and to control workers in crude drug and manufacturing pharmaceutical laboratories.

As in the previous edition, the taxonomic or phylogenetic system of classification has been retained as the main method of classification, for long experience has shown that it offers the least difficulties in presenting the subject to students and also has advantages over other systems of classification of plant and animal drugs in that it reduces to the minimum the number of drugs which have to be classified as miscellaneous, and it broadens the student's biological horizon. The morphological system of classification has been retained owing to its usefulness in associating and identifying crude drugs and other economic biological products.

The text has been thoroughly revised page by page; a number of monographs on old drugs which have become more or less obsolete and no longer useful even for type study have been deleted or reduced to paragraphs. Many monographs on newer biological drugs have been added as well as a large number of new illustrations, mostly original. Some of the older cuts have been replaced by better ones.

In Chapter II of Part I, a section on Pollen Grains, their structure, and methods of staining and mounting for microscopical examination, has been added.



Chapter I of Part I has been augmented with discussions on the subject of Animal Excreta in drugs, spices and food products, while Chapter III of Part I contains the newly introduced subjects of Allergens and Allergenic Preparations.

In Part II a new chapter on Antibiotics and Bacterial Biological Products has been added. Chapter IV of Part II, which replaces Chapter III of the previous edition, contains a number of new microanalytical methods, including the Wallis method for determining the percentage of starch in samples, methods for the determination of Vein Islet Numbers, Stomatal Indexes, and Palisade Ratios.

In the present edition, the official synonyms of drugs have been placed in italics in the drug monographs to distinguish them from the other common names in the Synonym paragraphs.

To Mr. L. C. Kencke who supplied the photographs on the production of Chondrus used in the frontispiece; to Mr. Raymond W. Vander Wyk, Instructor in Botany and Pharmacognosy at the Massachusetts College of Pharmacy, who prepared the drawings represented in Figs. 4 and 417; to Sharp and Dohme who supplied the photographs for the figures on *Penicillium notatum*; to Merck and Company who supplied the prints from which cuts were prepared on *Streptomyces griseus* and agar plate cultures of various bacteria showing the inhibitory effect of Streptomycin; to Mr. R. W. St. Clair, former Instructor in Materia Medica at the college, who supplied the colored photograph of digitalis used on the cover of the book and who extended valued service in making other photographs for a number of the new illustrations on medicinal plants; and to other workers and publishers from whom cuts or prints were borrowed for use in this edition and for which acknowledgment has been given in the text, the author's thanks are gratefully extended.

H. W. YOUNGKEN

BOSTON, MASSACHUSETTS

June 9, 1948

## PREFACE TO THE FIRST EDITION

The primary aim of the author, in preparing this book, was to supply a systematic text which could be used by students of pharmacognosy in colleges and universities where the science of pharmacognosy is taught either from the morphologic or taxonomic viewpoint or from both. To this end the contents of this volume have been arranged in two parts. Part I embraces the "Morphologic Consideration of Crude Drugs" and Part II the "Taxonomic Consideration of Crude Drugs."

The secondary aim of the author was to provide a book which could also be used by the drug analyst, pharmacognosist, wholesale and retail pharmacist and collector of crude drugs. To meet these varied requirements, there has been included information not only dealing with the synonyms, titles, habitats, ash, limit of impurities, physical characteristics, microscopical structure, and constituents of crude drugs of the *United States Pharmacopæia IX* and *National Formulary IV*, but in addition, many of the more common unofficial crude materials such as unofficial drugs, condiments, spices, cereals, tea, chocolate, etc., the adulterants of drugs, drug production and commerce, and descriptions of medicinal plants.

The tables of comparison between commercial varieties of crude drugs as well as between drugs and their more common past adulterants, it is hoped will prove helpful.

The World War has wrought some marked changes in the geographical sources of supply of many foreign drugs. Through considerable correspondence, the perusal of recent Consular reports and from up-to-date information kindly extended by Professor C. J. Zufall, Assistant Pharmacognosist of the United States Department of Agriculture, at the port of New York, valuable modern data has been acquired on the commercial phase of the subject which has been introduced in the text. A growing demand exists for information bearing upon the cultivation of medicinal plants. Many of these which can be grown successfully in the United States are considered under "Production" in Part II. In the arrangement of the plant families appearing in Chapter I of Part II, the author has adopted the Evolutionary system. In respect to nomenclature of plants, he has mainly followed Engler and Prantl's "Die natürlichen Pflanzenfamilien" and "Gray's New Manual of Botany," being careful to include, in respect to official vegetable drugs, those botanical names given in the latest editions of the "U.S.P." and "N.F.," so as to avoid confusion amongst students.

The names adopted for animals, appearing in Chapter II of Part II, are those appearing in the ninth edition of the U.S.P. and in the last edition of Maisch's "Organic Materia Medica."

In marshalling together the information contained within the covers of this volume, the author, in addition to his own research and study has consulted a wide range of foreign and domestic literature including books, bulletins of the United States Department of Agriculture, magazine articles and scientific papers. The titles and authors of many of these are given in the text and Bibliography and hereby acknowledged.

To Mr. Benjamin F. Hoffstein, Instructor in Pharmacognosy and Mr. Winfield F. Smith, Assistant in Botany, who aided in furnishing several of the drawings, and to Dr. Wm. R. Taylor of the University of Pennsylvania, who read the pages on the Algae, my thanks are due.

Grateful acknowledgment is made to Marin S. Dunn, A.M., Instructor in Botany and Pharmacognosy in the college, for material aid both on many of the drawings and in the compiling of the index. Finally, the writer desires to express his appreciation to Mr. I. A. Hagy of P. Blakiston's Son and Co. for the encouragement he has given during the publication of this book.

HEBER W. YOUNGKEN

# CONTENTS

	PAGE
PREFACE TO THE SIXTH EDITION . . . . .	vii
PREFACE TO THE FIRST EDITION . . . . .	ix

## *Part I*

### FUNDAMENTAL AND MORPHOLOGICAL CONSIDERATIONS OF DRUGS

#### CHAPTER I

##### FUNDAMENTAL CONSIDERATIONS

Pharmacognosy defined; problems in the practice of pharmacognosy and scope of the science; definition of drug; sources of drugs; occurrence of crude drugs; causes of their variation in quality; contamination; adulteration; substitution; official and unofficial drugs; drug titles; definitions of technical terms; collection of drugs; garbling; curing of drugs; drying of drugs; valuation of drugs; sampling of crude vegetable drugs; preservation of drugs; detection of insects, molds, yeasts and animal excreta in drugs and other economic products; historical . .	3
---	---

#### CHAPTER II

##### MORPHOLOGICAL CLASSIFICATION OF CRUDE DRUGS

ROOTS.—Definition. A. Titles, botanical origins and families of 1. Monocotyledonous roots official in the U.S.P. XIII . . . . .	21
B. Titles, botanical origins and families of dicotyledonous roots official in the N.F. VIII . . . . .	21
C. Titles, botanical origins and families of other medicinal roots . . . . .	21
Examination of physical characteristics of root drugs . . . . .	21
The study of microscopic structure of root drugs. Powdered roots. . . . .	23
TUBEROUS ROOTS.—Definition. Titles, botanical origin and families of tuberous roots official in the N.F. VIII. . . . .	23
TUBERS.—Definition. Study of potato tuber as a type. Potato starch. . . . .	23
RHIZOMES.—Definition. A. Titles, botanical origins and families of those official in U.S.P. XIII including 1. Fern rhizome and stipes and 2. Monocotyledonous rhizome. . . . .	24
B. Titles, botanical origins and families of Monocotyledonous and Dicotyledonous rhizomes official in the N.F. VIII . . . . .	24
C. Titles, botanical origins and families of other medicinal Monocotyledonous and Dicotyledonous rhizomes . . . . .	25
Examination of the physical characteristics of rhizome drugs. . . . .	25
Examination of the histology of rhizome drugs. . . . .	26
RHIZOMES AND ROOTS.—Titles, botanical origins and families of monocotyl and dicotyl rhizomes and roots official in the U.S.P. XIII and N.F. VIII . . . . .	27
Titles, botanical origins and families of other medicinal rhizomes and roots . . . .	28
Directions and notes on the examination of the physical characteristics and microscopical features of rhizomes and roots . . . . .	28

	PAGE
BULBS.—Definition. Titles, botanical origins and families of official and unofficial bulbs. Description of entire bulb of Squill. Description of Scilla and Allium .	29
CORM.—Definition. Title, botanical origin, family and characteristics of Colchici Cormus. . . . .	29
BARKS.—Definition. Titles, botanical origins and families of the official barks of the U.S.P. XIII and N.F. VIII . . . . .	30
Titles, botanical origins and families of other medicinal barks . . . . .	30
Directions and notes on the examination of the physical characteristics and histology of barks. Powdered barks . . . . .	31
WOODS.—Definition. Titles, botanical origins and families of the wood drugs official in the U.S.P. XIII and N.F. VIII. Other medicinal and dye woods . . . . .	33
PITH.—Title, botanical origin and family of Sassafras Medulla. . . . .	33
Definition and examples of official sapwood and heartwood . . . . .	33
Methods for the microscopic examination of woods. . . . .	34
LEAVES.—Titles, botanical origins and families of those official in the U.S.P. XIII and N.F. VIII. . . . .	34
Titles, botanical origins and families of other medicinal leaves . . . . .	34
Titles, botanical origins of official and unofficial leaflet drugs and of official leaf bud	35
Leaves defined. Directions and notes on the examination of the physical characteristics and microscopical features of leaves. Powdered leaves . . . . .	35
STEMS.—Definition. Titles, botanical origins and families of official and unofficial aerial stem drugs . . . . .	37
Directions and notes on the gross and microscopical examination of stems. Powdered stems. . . . .	37
LEAVES AND FLOWERING OR FRUITING TOPS.—Titles, botanical origins and families of those official in the U.S.P. XIII and N.F. VIII. Other medicinal leaves and flowering tops . . . . .	40
ENTIRE PLANT DRUGS.—Titles, botanical origins and families of Irish Moss in the N.F. VIII and other entire plant drugs . . . . .	41
OVERGROUND PORTIONS OF PLANTS.—Titles, botanical origins and families of medicinal overground parts of plants . . . . .	41
FLOWERS AND FLORAL PARTS.—Flowers defined. Titles, botanical origins and families of U.S.P. XIII and N.F. VIII and other flower drugs. . . . .	41
Directions and notes on the gross and microscopic examination of drug flowers and inflorescences . . . . .	42
POLLEN GRAINS.—Definition, structure, and methods of staining and mounting for microscopic examination . . . . .	44
FRUITS.—Definition. Titles, botanical origins, kinds and families of fruits official in the U.S.P. XIII and N.F. VIII. Other medicinal fruits . . . . .	44
Directions for the study of the physical characteristics and microscopic structure of fruit drugs. Powdered fruits . . . . .	46
SEEDS AND SEED PARTS.—Seed defined. Titles, botanical origins and families of exalbuminous and albuminous seeds official in the U.S.P. XIII and N.F. VIII. . . . .	47
Cotyledons and Powder prepared from kernels official in the N.F. VIII. . . . .	47
Other medicinal seeds and Paste chiefly consisting of crushed seeds. Directions and notes on the gross and microscopical examination of seed drugs. Powdered seeds. . . . .	47
TRICHOMES.—Definition. Titles, botanical origins and families of non-glandular and glandular trichomes official in the U.S.P. XIII and N.F. VIII . . . . .	50
Titles, botanical origins and families of other plant hairs . . . . .	50
GUMS, MUCILAGE, RESINS, GUM RESINS, OLEORESINS AND BALSAMS.—Definitions. Titles, botanical origins and families of those official in the U.S.P. XIII and N.F. VIII. . . . .	50

INSPISSATED JUICES, DRIED LATEX, TARS AND EXTRACTS.—Definitions. Titles, botanical origins and families of those official in the U.S.P. XIII and N.F. VIII . . . .	52
MISCELLANEOUS DRUGS OF VEGETABLE ORIGIN.—Titles, botanical origins and families of sugar, starch, camphor, rice polishings, diatom frustules, mold products, sclerotium, spores, dried purified latex, a purplish red powder, and excrescence official in the U.S.P. XIII and N.F. VIII. Yeast . . . . .	52
ANIMAL DRUGS.—Titles, zoological origins and families of those official in the U.S.P. XIII and N.F. VIII. . . . .	53

## CHAPTER III

## THERAPEUTIC CLASSES OF DRUGS

Definitions and examples of 87 classes of therapeutic agents employed in the treatment of disease . . . . .	56
ALLERGENS.—Allergy and Allergens defined. Allergenic materials. Plant Pollens. Pollen Counts . . . . .	61
ALLERGENIC PREPARATIONS . . . . .	64

*Part II*

## TAXONOMIC CONSIDERATION OF DRUGS

## CHAPTER I

## DRUGS OF VEGETABLE ORIGIN

Div. I Thallophyta . . . . .	69
ALGÆ . . . . .	69
Bacillariæ or Diatoms . . . . .	69
Laminariaceæ Family . . . . .	72
Lessoniaceæ Family . . . . .	72
Fucaceæ or Rockweed Family . . . . .	73
Gigartinaceæ Family . . . . .	76
Gelidiaceæ Family . . . . .	79
FUNGI . . . . .	81
Saccharomycetaceæ or Yeast Family . . . . .	82
Hypocreaceæ Family . . . . .	85
Polyporaceæ or Pore Fungi Family . . . . .	91
Agaricaceæ or Gill Fungi Family . . . . .	92
LICHENS . . . . .	93
Parmeliaceæ or Parmelia Family . . . . .	94
Div. II Bryophyta . . . . .	95
Div. III Pteridophyta . . . . .	96
LYCOPODINEÆ . . . . .	96
Lycopodiaceæ or Club Moss Family . . . . .	96
FILICINEÆ . . . . .	97
Polypodiaceæ or Polypodium Family . . . . .	99
Div. IV Spermatophyta (Phanerogamia) . . . . .	106
GYMNOSPERMÆ . . . . .	106
Gnetaceæ or Gnetum Family . . . . .	106
Pinaceæ or Pine Family . . . . .	113

	PAGE
ANGIOSPERMÆ . . . . .	131
A. MONOCOTYLEDONEÆ . . . . .	131
Gramineæ or Grass Family . . . . .	131
Palmæ or Palm Family . . . . .	168
Araceæ or Arum Family . . . . .	176
Liliaceæ or Lily Family . . . . .	179
Dioscoreaceæ or Yam Family . . . . .	210
Iridaceæ or Iris Family . . . . .	212
Zingiberaceæ or Ginger Family . . . . .	221
Marantaceæ or Arrowroot Family . . . . .	236
Orchidaceæ or Orchid Family . . . . .	238
B. DICOTYLEDONEÆ . . . . .	243
ARCHICHLAMYDEÆ . . . . .	243
Piperaceæ or Pepper Family . . . . .	244
Salicaceæ or Willow Family . . . . .	253
Myricaceæ or Wax Myrtle and Bayberry Family . . . . .	258
Juglandaceæ or Walnut Family . . . . .	263
Betulaceæ or Birch Family . . . . .	264
Fagaceæ or Beech Family . . . . .	265
Ulmaceæ or Elm Family . . . . .	273
Moraceæ or Mulberry Family . . . . .	275
Santalaceæ or Sandalwood Family . . . . .	285
Loranthaceæ or Mistletoe Family . . . . .	286
Aristolochiaceæ or Birthwort Family . . . . .	287
Polygonaceæ or Buckwheat Family . . . . .	291
Chenopodiaceæ or Goosefoot Family . . . . .	300
Phytolaccaceæ or Poke Family . . . . .	303
Magnoliaceæ or Magnolia Family . . . . .	305
Myristicaceæ or Nutmeg Family . . . . .	308
Ranunculaceæ or Crowfoot Family . . . . .	313
Berberidaceæ or Barberry Family . . . . .	343
Menispermaceæ or Moonseed Family . . . . .	351
Monimiaceæ or Monimia Family . . . . .	360
Lauraceæ or Laurel Family . . . . .	361
Papaveraceæ or Poppy Family . . . . .	379
Fumariaceæ or Fumitory Family . . . . .	389
Cruciferae or Mustard Family . . . . .	390
Hamamelidaceæ or Witch Hazel Family . . . . .	398
Rosaceæ or Rose Family . . . . .	404
Leguminosæ or Pea and Bean Family . . . . .	427
Geraniaceæ or Geranium Family . . . . .	479
Linaceæ or Flax Family . . . . .	482
Erythroxylaceæ or Coca Family . . . . .	485
Zygophyllaceæ or Caltrop Family . . . . .	489
Rutaceæ or Rue and Citrus Family . . . . .	490
Simarubaceæ or Ailanthus Family . . . . .	505
Burseraceæ or Myrrh Family . . . . .	507
Meliaceæ or Mahogany Family . . . . .	510
Polygalaceæ or Milkwort Family . . . . .	512
Euphorbiaceæ or Spurge Family . . . . .	516
Anacardiaceæ or Sumac Family . . . . .	529
Celastraceæ or Staff Tree Family . . . . .	537

	PAGE
Sapindaceæ or Soapberry Family. . . . .	540
Aceraceæ or Maple Family . . . . .	542
Rhamnaceæ or Buckthorn Family . . . . .	543
Sterculiaceæ or Cola Family. . . . .	553
Malvaceæ or Mallow Family . . . . .	560
Theaceæ or Tea Family. . . . .	568
Guttiferæ or Gamboge Family. . . . .	572
Canellaceæ or Canella Family . . . . .	574
Flacourtiaceæ or Flacourtia Family. . . . .	575
Passifloraceæ or Passion Flower Family. . . . .	577
Caricaceæ or Papaw Family. . . . .	578
Cactaceæ or Cactus Family . . . . .	579
Thymeleaceæ or Mezereon Family . . . . .	583
Lythraceæ or Loosestrife Family. . . . .	585
Punicaceæ or Pomegranate Family. . . . .	587
Myrtaceæ or Myrtle Family. . . . .	592
Araliaceæ or Ginseng Family . . . . .	605
Umbelliferæ or Parsley Family. . . . .	608
2. SYNPETALÆ. . . . .	639
Ericaceæ or Heath Family . . . . .	639
Sapotaceæ or Star Apple Family. . . . .	645
Styraceæ or Benzoin Family. . . . .	647
Oleaceæ or Olive Family . . . . .	649
Loganiaceæ or Nux Vomica Family. . . . .	655
Gentianaceæ or Gentian Family . . . . .	669
Apocynaceæ or Dog Bane Family . . . . .	677
Asclepiadaceæ or Milkweed Family . . . . .	685
Convolvulaceæ or Morning Glory Family . . . . .	689
Hydrophyllaceæ or Water Leaf Family . . . . .	697
Boraginaceæ or Borage Family. . . . .	700
Verbenaceæ or Vervain Family . . . . .	703
Labiata or Mint Family . . . . .	706
Solanaceæ or Nightshade Family. . . . .	750
Scrophulariaceæ or Figwort Family. . . . .	784
Pedaliaceæ or Sesame Family . . . . .	800
Plantaginaceæ or Plantain Family . . . . .	802
Rubiaceæ or Madder Family . . . . .	811
Caprifoliaceæ or Honeysuckle Family. . . . .	835
Valerianaceæ or Valerian Family. . . . .	852
Cucurbitaceæ or Gourd Family . . . . .	856
Campanulaceæ or Blue Bell Family (including Lobeliaceæ) . . . . .	861
Compositæ or Daisy Family. . . . .	865

## CHAPTER II

## DRUGS OF ANIMAL ORIGIN

Phylum Protozoa . . . . .	910
CLASS.—SARCODINA . . . . .	910
ORDER FORAMINIFERA . . . . .	910
The Metazoa . . . . .	911
PHYLUM PORIFERA. . . . .	911
Commercial Sponges . . . . .	911



	PAGE
PHYLUM—ANNELIDA. . . . .	912
CLASS.—HIRUDINEA. . . . .	912
PHYLUM MOLLUSCA. . . . .	912
CLASS.—CEPHALOPODA. . . . .	913
PHYLUM ARTHROPODA. . . . .	913
CLASS.—INSECTA. . . . .	913
ORDER HEMIPTERA. . . . .	914
SUBORDER HOMOPTERA. . . . .	914
Family Coccidæ. . . . .	914
ORDER COLEOPTERA. . . . .	917
Family Meloideæ. . . . .	918
ORDER HYMENOPTERA. . . . .	920
Family Apidæ. . . . .	920
PHYLUM CHORDATA. . . . .	922
SUB-PHYLUM VERTEBRATA. . . . .	922
CLASS.—ELASMOBRANCHII. . . . .	922
CLASS.—PISCES. . . . .	923
Family Gadidæ. . . . .	923
Family Pleuronectidæ. . . . .	924
CLASS.—REPTILIA. . . . .	927
ORDER SQUAMATA. . . . .	927
Family Viperidæ. . . . .	927
CLASS.—AVES. . . . .	928
Family Phasianidæ. . . . .	928
CLASS.—MAMMALIA. . . . .	929
ORDER ARTIODACTYLA. . . . .	929
Family Bovidæ. . . . .	929
Family Suidæ. . . . .	934
Family Moschidæ. . . . .	936
ORDER CARNIVORA. . . . .	938
Family Viverridæ. . . . .	938
ORDER PRIMATES. . . . .	939
Family Hominidæ (Human Serum, Plasma, Plasma Fractions, and Immune Globulin). . . . .	939
ORDER CETACEA. . . . .	941
Family Physeteridæ. . . . .	941
ENDOCRINE GLAND PRODUCTS. . . . .	942
ANIMAL DRUGS FROM VARIED SOURCES. . . . .	969
VITAMINS. . . . .	969

### CHAPTER III

#### ANTIBIOTICS AND BACTERIAL BIOLOGICAL PRODUCTS

ANTIBIOTICS.—Definition. Penicillin and its preparation. Streptomycin. Tyrothricin. Chlorophyll. Bacitracin. . . . .	972
BACTERIAL BIOLOGICAL PRODUCTS.—Definitions of kinds. Antitoxins. Toxoids. Diagnostic Toxins. Sera. Vaccines. Tuberculins. . . . .	981
BIBLIOGRAPHY. . . . .	991

## CHAPTER IV

## MICROANALYTICAL METHODS

MICROANALYSIS.—Definition. Scope and preparation of materials. . . . .	993
QUANTITATIVE MICROANALYSIS.—Problems and Methods. . . . .	994
MICROCHEMICAL TESTS. . . . .	997
OPTICAL-CRYSTALLOGRAPHIC METHODS . . . . .	998
MICROMETRY . . . . .	999
STANDARDISATION OF OCULAR MICROMETER. . . . .	1000
VEIN ISLETS AND VEIN ISLET NUMBERS . . . . .	1001
STOMATAL INDEX.—Method for determination. . . . .	1001
PALISADE RATIO.—Method for determination. . . . .	1002
EXAMINATION OF POWDERED DESICCATED ENDOCRINE GLANDS. . . . .	1003
DISTINCTIONS BETWEEN THE POWDERED DESICCATED ANTERIOR AND POSTERIOR PITUITARY . . . . .	1004
PERMANENT RECORDS . . . . .	1006
BIBLIOGRAPHY. . . . .	1007
INDEX . . . . .	1008



PART I

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FUNDAMENTAL AND  
MORPHOLOGICAL CONSIDERATION  
OF  
DRUGS



## CHAPTER I

### FUNDAMENTAL CONSIDERATIONS

**Pharmacognosy** is the science which treats of the history, production, commerce, collection, selection, identification, valuation, preservation and use of drugs and other economic materials of plant and animal origin.

The term "pharmacognosy" was first used by C. A. Seydler in his dissertation, entitled "*Analecta pharmacognostica*," which appeared in 1815. It is derived from the Greek words *pharmakon*, drug or medicine, and *gnosis*, knowledge, and literally means the knowledge of drugs. The term, "pharmacology," literally meaning a discourse on drugs, is applied, to-day, to the study of the action of drugs or other chemical agents upon living organs or organisms.

In the practice of pharmacognosy, a number of scientific disciplines, including botany, chemistry, zoology, physics, and genetics are applied to the solution of problems pertaining to the identity, purity, quality, and preservation of drugs, spices, insecticides, rodenticides, fibers, gums, resins, waxes, oils, cereals and cereal products, and various other economic materials obtained from the plant and animal kingdoms.

### DRUGS

The term "**drug**," according to the Federal Food, Drug and Cosmetic Act of 1938, is applied to (1) articles recognized in the official United States Pharmacopœia, official Homeopathic Pharmacopœia of the United States, the official National Formulary or any of their Supplements, and (2) articles intended for use in the diagnosis, cure, mitigation, treatment or prevention of disease in man or other animals, and (3) articles (other than food) intended to affect the structure or any function of the body of man or other animals, and (4) articles intended for use as a component of any article specified in clause (1), (2) or (3); but does not include devices or their components, parts or accessories.

Drugs are derived from the mineral, vegetable and animal kingdoms. They may occur in the crude or raw form, as dried or fresh unground or ground organs or organisms or natural exudations of these, when they are termed "*crude drugs*," or as derived substances, such as alkaloids, glycosides, alcohols, esters, aldehydes or other constituents or mixtures of constituents separated from the plant or animal, or they may occur as synthetic products, as synthetic ephedrine, camphor, menthol, methyl salicylate, etc., or as preparations of various natural or synthetic substances.

**Crude Drugs** occur in commerce either in the entire, nearly entire, or broken condition, as in most roots, rhizomes and roots, barks, fruits, seeds and some leaves, or in the matted together condition, as in *Chondrus* and many leaf and leaf and top drugs, in the form of transverse slices, as in *Colchicum Corm*, *Bry-*

ony and Calumba, in longitudinal slices, as *Veratrum Viride*, etc., in the cut form, as some of the commercial *Althæa*, cut Senna and Licorice root, in the shredded form as some domestic Couch Grass, in the pressed condition, as in the pressed herbs, in the peeled condition, as *Colocynth*, or deprived of cork (periderm), as Jamaica Ginger, *Althæa*, *Ulmus*, etc., in the peeled and elongated cut form, as orris fingers, or in the ground or powdered condition, as most drugs, or finally, they may be first powdered and then molded into various shapes, as "rhubarb fingers."

There has always been a wide variance in the *quality* of crude drugs. This is generally due to one or more of the following causes: (1) Deficiency in knowledge or carelessness on the part of the collector; (2) want of care in preparing them for the market; (3) carelessness in garbling them; (4) carelessness in storing and preserving them; (5) accidental contamination with another drug; (6) adulteration; and (7) substitution.

**Contamination** indicates an impurity left present by the collector or admitted through accident, carelessness or ignorance but without intent to defraud. Odors and tastes from other nearby stored drugs may contaminate and thus lower the quality of a drug.

**Adulteration** indicates either the *admission* of impurities or the *removal* of all or a part of the valuable portion of a drug, or it may indicate the *addition* of low grade or spoiled drug with evident intent to defraud. Examples: removal of volatile oil from whole clove, an excess of stem portion with aconite, *matricaria*, *lobelia*, etc.

**Substitution** indicates the replacing of one drug either in whole or in part by another drug. Substitution usually is done with fraudulent intent but, under certain conditions, a substitution may be justified, and the U.S.P. and N.F. Revision Committees have in the past recognized such specific conditions, as in the case of *Chaulmoogra* Oil where fixed oil from ripe seed of other species of *Hydnocarpus* not specified in the definition of that drug may be substituted when conforming with prescribed requirements in the monograph of that drug, or, as in the case of Valerian where the rhizome and roots of *Valeriana Wallichii* or Indian Valerian were permitted by N. F. Interim Revision to be substituted for those of *V. officinalis* as a war emergency expedient, while the latter were unobtainable from abroad or not produced here in sufficient amounts for medicinal needs.

**Official and Unofficial Drugs.**—Drugs are either official or unofficial. An **official drug** is one that is listed and described in a book recognized by the government as the legal authority for standards. In the United States all drugs are official, at present, which are listed in the United States Pharmacopœia XIII, the National Formulary VIII and The Homeopathic Pharmacopœia of the United States, 6th revised edition (1941) and their Supplements. Every drug in either of these three books on standards has a Latin official name and an English official name. Some of the drugs in addition have one or more official common names or **synonyms**. *Unofficial drugs*, in the United States and its possessions, are those which are not recognized in the official U.S.P., N.F. or

H.P. or their Supplements. Many of these are recognized in the pharmacopœias of other countries and are in drug commerce.

The **English official name** or **English title** of a drug is usually a direct translation of the Latin official name.

The **Latin official name** or **Latin title** of a plant or animal drug is derived either from the name of the genus of the plant or animal yielding the drug, as *Podophyllum* and *Cantharis*, or from the specific name, as *Ipecacuanha*, or from the combined names of the genus and species, as *Viburnum Prunifolium*, or from a previous synonym, as *Cascara Sagrada*, or from other sources, as *Pix Pini*, *Opium*, etc. The Latin official name heads the monograph on the drug.

The **official synonyms** follow the Latin official name in some of the monographs. They either represent vernacular names or formerly used official titles of the drug.

The **official definition** of a crude vegetable or animal drug is found as the initial paragraph beneath the name or names of a drug in the U. S. Pharmacopœia or National Formulary. It consists of the part used, botanical or zoological origin, and family, and in some instances of the commercial varieties, habitat, time of collection and preparation for the market.

The **botanical origin** represents the scientific name of the plant or scientific names of the plants yielding the drug. Thus, the botanical origin of Wild Cherry Bark is *Prunus serotina*; that of Burdock Root is *Arctium Lappa* and *Arctium minus*; that of American Wormseed is *Chenopodium ambrosioides* var. *anthelminticum*.

The **zoological origin** represents the scientific name of the animal or scientific names of the animals yielding the drug. Thus, the zoological origin of *Cantharides* is *Cantharis vesicatoria*, whilst that of Civet is *Viverra civetta* and *Viverra zibetha*.

The **habitat** is the original home of the plant or animal yielding the drug. Plants or animals found thriving in their original or native home are said to be *indigenous* thereto. When these organisms thrive in some locality other than that to which they are native, they are said to be *naturalized*. Thus, the Belladonna plant (*Atropa Belladonna*) is indigenous to central and southern Europe and naturalized in the United States.

The **commercial origin** of a drug represents its trade or commercial source. This may be the country or district in which the plant or the animal furnishing the drug is grown or the country or the port from which the drug is shipped. Thus, English Valerian is the product of plants grown in England; Shensi Rhubarb is the product of plants grown in the Shensi district of China; Bombay Mace is the product of plants grown in the interior of India but shipped from the port of Bombay; Alexandria Senna is the product of plants grown in El Hejaz but shipped in part to the markets of the world from Cairo, Egypt.

The **official rubric** or **purity rubric** of a drug is the standard of strength, quality and purity to which it must measure. In a number of the botanical monographs of the U.S.P. and N.F., that portion of the purity rubric which deals with the standard of strength or potency of the drug immediately follows the



official definition, usually as a separate paragraph. In some instances the official rubric specifies the limit of tolerance for impurities not harmful in themselves, as moisture, foreign organic matter, acid-insoluble ash, etc., in others a percentage requirement of active chemical constituents, in others, a standard of biological activity, when tested on some specified animal. The tolerance limits for impurities are given under paragraphs following the Description paragraph in the current U.S.P. and N.F.

The **official description** follows the official definition and generally comprises the occurrence, external and internal appearances, fracture, odor and taste. In some instances the histology of the crude drug and the color and microscopical characteristics of the powdered drug are also included as well as *tests for identity, quality, purity*, etc.

The **fracture** of a drug is the way in which it breaks when subjected to sufficient pressure and the character of its broken surfaces. The terms used to describe drug fracture include the following:

*Complete*.—Breaking clean across.

*Incomplete*.—Breaking only part way across.

*Fibrous*.—Breaking in such a manner that the broken ends have a jagged appearance from projecting fibers or fibro-vascular bundles.

*Flexible*.—Breaking only by tearing or twisting, though readily bending.

*Brittle*.—Crumbling readily into fragments.

*Granular*.—A peculiar, grain-like appearance of the broken surface.

*Hard*.—Exhibiting a compact surface when broken.

*Horny*.—Exhibiting a hard, horn-like surface.

*Mealy*.—Breaking readily across the drug and exhibiting a starchy, broken surface.

*Resinous*.—Exhibiting a smooth, glossy, broken surface.

*Conchoidal*.—Resembling the resinous fracture, but the surfaces are characteristically curved in convex and concave fashion.

*Sharp*.—Breaking straight across.

*Short*.—Breaking quickly.

*Smooth*.—Breaking with a smooth surface.

*Splintery*.—Breaking irregularly across into pieces with larger and smaller projecting edges and splinters.

*Spongy* (Corky).—A break peculiar to vegetable drugs having good-sized intercellular-air-spaces, as Calamus and Iris Versicolor, in which the side toward which the piece is being bent is compressed while the opposite side stretches before the fracture occurs.

*Tough*.—Breaking only after twisting or tearing.

*Uneven*.—Breaking in such a way as to exhibit irregularly broken surfaces.

*Waxy*.—Exhibiting peculiar, dull, granular, broken surfaces.

*Weak*.—Breaking quickly with little effort.

The **official assay** is a test designed either to determine the amount of medicinally active substance or substances present in a drug or its potency or strength. The assay is termed (1) *proximate*, when it is applied to a vegetable drug or

plant to determine the amount of the organic constituent or constituents present, as in the determination of the amount of strychnine in *Nux Vomica*, volatile oil in clove, etc., (2) *colorimetric*, when the tinctorial power of a drug is compared with a definite color standard, as in the assay of Cudbear, or (3) *biological*, when the effect of a drug on an animal is compared with the effect of a standard substance on the same kind of animal, as in the assays of Aconite, *Digitalis*, Ergot, Cod Liver Oil, etc.

The **official dose** is given in the U.S.P. and N.F. for most of the drugs included which are administered internally. This dose is most frequently an average usual dose for an adult human. The **average dose** is a dose which may be expected ordinarily to produce the therapeutic effect in those conditions for which the drug is most commonly employed. Unless otherwise specified the average doses are for oral administration to human adults. Sometimes an average dose is specified for children and for certain specific animals. In other instances the dose is specified to be given hypodermically, subcutaneously, intravenously or intramuscularly. In this text average doses are given for many official drugs which have no official dose for the guidance of the dispenser.

**Collection of Drugs.**—The best time for the collection of various drugs is considered in other parts of the text. It is the result of painstaking investigations in chemistry and pharmacodynamics. It may be said broadly, however, that the general rules for the collection of the greater number of vegetable crude drugs in each of the several classes are as follows: Autumn for roots, rhizomes, bulbs, tubers or barks; when fully expanded for flowers; just before expansion for leaf or flower buds; when the flowers of the plant are opening for leaves; when full grown but unripe for fruits; and when fully developed for seeds. Gums and oleo-gum-resins should be gathered during dry weather, and barks after a rainy period when they separate more readily from the wood.

In the collection of fleshy subterranean plant organs such as Squill, Poke Root, American Hellebore, *Calumba*, etc., it is necessary to slice them before they are dried, in order to properly insure against mold attack. Mold spores germinate quickly in the presence of warmth and moisture and so these drugs should be dried rapidly and yet at a temperature not high enough to injure their active constituents.

It is well for the collector to know the plants yielding the drugs he seeks to collect; indeed he should be thoroughly acquainted with their most important gross features, but it is folly to expect him to be that sufficiently learned in morphology or taxonomy as to be able to distinguish between closely related varieties of a given species. This is a matter for the drug broker's or wholesaler's pharmacognosist to determine.

**Garbling.**—All crude drugs should be carefully garbled before being sold to the public or used in the manufacture of preparations. By *garbling* is meant the removal of extraneous matter from the drug, such as sand, dirt, or parts of plants which are at variance with the officially indicated portion. In many instances it is practically impossible to prevent some degree of harmless contamination.

For this reason the pharmacopœia and national formulary give a limit of permissible impurities after many of the drug definitions.

**Curing.**—It is well known that certain crude drugs must undergo a *curing process* in order that important active constituents may be developed. This generally involves a slow drying or sweating during which substances of biologic origin, known as enzymes, initiate chemical changes which result in the alteration of their constituents. Among these might be mentioned Coca, Guarana, Gentiana, Belladonna, Hyoscyamus, Tonka, Sabal, Tobacco, and Vanilla.

In the cases of Cascara and Frangula barks it is necessary to destroy a contained irritant principle, before they can be used. This may be accomplished either by heating these barks at a temperature of 100°C. for 48 hours or by keeping them at least a year before using.

**Drying of Drugs.**—Crude drugs are dried in order that sufficient moisture may be removed from them to insure their good keeping qualities. Effective drying is best accomplished through the proper regulation of temperature, humidity and circulation of air. The loss of moisture should be gradual. Freshly gathered drugs are either air-dried or dried by artificial heat.

In air drying, the drug is spread on trays, screens or floors or hung on wires in a room where the air can properly circulate. At the beginning, the fresh drug is spread out one layer thick and, as drying progresses, it is often piled in thicker layers which are frequently turned. Drying in the shade under a roof, as on a barn floor, is recommended for most drugs, although many barks, rhizomes and roots can be adequately dried in the sun. In all cases the drying drug should be protected from rain and humid atmosphere.

In drying by artificial heat, a controlled heating and ventilating system is recommended. While small lots can be successfully dried in a heated room, special drying houses or drying apparatus equipped with tiers of trays or racks and a controlled heating and ventilating system is desirable (see Farmer's Bull. 1231, U.S. Dep. Agr.). For most barks, roots, rhizomes, leaves, herbs, seeds and some fruits, it has been found that a gradual raising of the temperature from 25°C. to 50°C. will give a satisfactory product; in the case of flowers and drugs containing volatile constituents, the temperature should not be raised over 35°C.

**Valuation of Drugs.**—The chief methods employed in evaluating drugs are (1) organoleptic, (2) microscopical, (3) physical, (4) chemical, and (5) biological. The Organoleptic method of evaluation is a qualitative method which calls into use the sense organs of the worker. It involves the application of sight, smell, taste, touch, and occasionally hearing. In these tests the shape and size, external color and markings, fracture, texture or feel, internal color and markings, odor, and taste are noted. In some cases the organoleptic tests alone suffice. They are of first importance in the preliminary examination of drugs since the general appearance of the sample, its odor and taste will frequently indicate whether it will satisfy certain official standards. In others, as in the case of all powdered and ground drugs of vegetable or animal origin, the use of the compound microscope is essential.

**Microscopical methods** of valuing drugs are indispensable in the identification of small fragments of crude drugs and of powdered drugs and in the detection of their adulterants, for these possess few features other than color, odor and taste whereby clues toward their identity may be afforded. Moreover, owing to the similarity of some plant organs of allied species, definite identification even of certain entire or nearly entire, cellular vegetable drugs cannot be made without the examination of mounts of thin sections of them under a compound microscope. Every plant possesses a characteristic histology in respect to its organs and diagnostic features of these are ascertained through the study of the tissues and their arrangement, cell walls and cell contents, when properly mounted in suitable stains, reagents or mounting media.

In many instances a good idea of the quality of a drug can be ascertained by employing *microchemic methods*. These may consist (1) of examining mounts of sections or powdered drug in various reagents which either form salts of the contained active principles, that have constant characters (microcrystallization), or show definite color reactions, or (2) *isolation of constituents* of the powdered drug with a suitable *solvent*, filtering 2 or 3 drops of the extract on to a slide, permitting the solvent to evaporate and examining the residue, or (3) *isolation* of a constituent by *microsublimation*.

It is often possible to determine whether a powdered drug has been exhausted by examining the crystals found in its sublimate. These have been found to be characteristic for many drugs. *Microsublimation* upon a slide is superior technique to test tube sublimation in that the sublimate may be directly examined under the microscope without mechanical alteration. The watch glass and slide method of microsublimation is carried out as follows: Place 5 to 15 mg. of powdered drug in a shallow watch glass. Cover watch glass with one or two microslides and place on electric hot plate or on wire gauze over tripod from 8 to 10 cm. above flame of alcohol lamp or microburner. The flame should not exceed 1 cm. in height. Heat carefully until sublimate forms (usually in 1 or 2 minutes). The slide is then reversed and placed on desk until cool when the sublimate is examined dry, without cover slip, under the microscope.

**Physical methods** of evaluation are employed when it is necessary to determine the solubility, specific gravity, optical rotation, melting point, congealing point, water content of a drug or the degree of elasticity of fibers. The characteristic fluorescence of certain drugs, chemicals and preparations, when examined under filtered *ultra-violet light*, is made use of as an aid in the diagnosis of these and in the detection of adulteration. *Polarized light* is used in the examination of starches and the detection of small amounts of calcium oxalate in drug sections and powdered drugs. Crystals of calcium oxalate appear bright on a black background. Many starches exhibit distinct polarization crosses in polarized light, others do not.

**Chemical methods** of evaluation are employed when it is necessary to determine the percentage of active principle or principles, of oil, fat, carbohydrate, protein, ash, acid-insoluble ash, or crude fiber present in the sample (quantitative chemical methods) or when it is essential to determine by the use of reagents

the color reactions or solubilities of drugs or their constituents (qualitative chemical methods).

**Biological or Pharmacodynamic methods** are employed in valuing and standardizing a number of potent drugs or their preparations, such as Digitalis, Strophanthus, Apocynum, Liver Extract, Posterior Pituitary, Powdered Stomach, Vitamins, Aconite, Ergot, etc. These involve the study of the effect of a preparation or a constituent of the drug on normal, healthy animals or plants.

**Sampling of Crude Vegetable Drugs.**—The problem of obtaining truly representative samples of a crude vegetable drug is one often requiring experience, judgment and skill. The samples are taken either by means of a specially devised tool called a trier or sampler or by hand.

The U.S.P. XIII recommends the following schedule for sampling vegetable drugs:

No. of packages in shipment	No. of packages to be sampled
1 to 10	1 to 3
10 to 25	3 to 4
25 to 50	4 to 6
50 to 75	6 to 8
75 to 100	8 to 10
Over 100	Not less than 10

An excellent sampler has been developed by Mr. L. J. Schwarz of New York (see Fig. 1) which consists of a hollow drill spindle with provision for fitting a hollow drill on one end and a quick release and cap on the other. The drills used are made from tool steel and are of knife-edge or saw-tooth design. They can be used interchangeably depending upon the nature of the material which is to be sampled. The saw-toothed drill is better for tightly baled leaves, whereas the knife-edge drill is better for sarsaparilla and ipecac, etc. One end of the hollow spindle is threaded to accommodate the drill or an extension drill spindle. The other end is provided with pins for the attachment of the end cap. The end cap is provided with a shank suited to a standard brace, an arrangement which will permit of hand drilling.

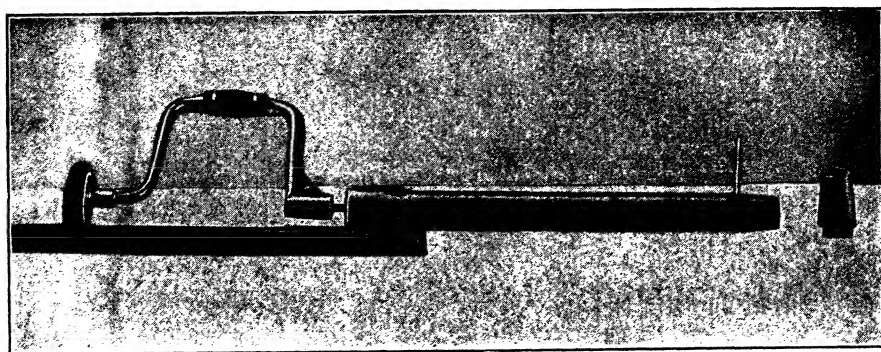


FIG. 1.—Sampler employed in taking samples of various kinds of crude vegetable drugs.  
(Courtesy of L. J. Schwarz.)

In using this sampler, the operator cuts out the desired number of cores of the drug to be sampled. As each core is cut, the end cap is released and the drug column in the sampler is forced into a suitable container by means of a wooden plunger.

While the sampler described is suited for the sampling of a large number of drugs, it is unsuited for material baled under hydraulic pressure, for heavy barks such as yohimbe or such roots as gentian, hydrangea, etc., or for some of the gum drugs.

The U.S.P. XIII gives 3 methods for the withdrawal of official samples of vegetable drugs. They are essentially as follows:

1. *For gross samples whose component parts are 1 cm. or less in any dimension, and for all powdered or ground drugs.* It is recommended that a sampler be employed which removes a core from the top to the bottom of the container, not less than 2 cores being taken in opposite directions.

If the total weight of the drug to be sampled is less than 200 pounds (100 kilos), at least 250 Gm. constitutes an official sample; when the total weight exceeds 200 pounds, repeated samples shall be taken by the above method according to the schedule recommended for sampling, mixed and quartered, 2 of the diagonal quarters being rejected, the remaining 2 quarters being combined and carefully mixed and again quartered in the same way until 2 of the quarters weigh at least 250 Gm., which latter quarters shall constitute an official sample.

2. *For gross samples whose component parts are over 1 cm. in any dimension,* the sample is taken by hand. When the total weight of the drug sampled is less than 200 pounds (100 kilos), at least 500 Gm. constitutes an official sample and this must be taken from different parts of the container or containers. When the total weight is in excess of 100 kilos, repeated samples must be taken by the above method and according to the schedule recommended for sampling, mixed and quartered, 2 of the diagonal quarters being rejected, the remaining 2 quarters carefully combined, mixed and again subjected to the quartering process until 2 of the quarters weigh not less than 500 Gm. which latter quarters shall constitute an official sample.

3. *For samples whose total weight is less than 20 pounds (10 kilos).* Methods 1 and 2 are recommended, but smaller quantities should be withdrawn and the final official sample should not weigh less than 125 Gm.

In addition to the methods of withdrawal outlined above, the official sample is permitted to consist of the total amount of a direct purchase made by Federal, State or Municipal Food and Drugs' Act enforcement officials.

**Preservation of Drugs.**—Insects, mites, molds, rusts, moisture and temperature are important factors which must be taken into consideration, if crude drugs are to be kept so as to be of salable appearance and therapeutically active.

Most of the crude drugs are subject to attacks by *insects* which render them unsightly and so unfit for sale. Chief among these pests, which ruin huge amounts of crude drugs yearly, are various species of beetles (*Coleoptera*) and

moths (*Lepidoptera*). Both of these orders of insects have four stages in their life histories, viz.: egg, larva, pupa and imago. The eggs are frequently deposited on the drug by the adult (imago) female, before the drug reaches the dealer (at times before it is even collected). Under favorable conditions, such as are often prevalent in places where drugs are stored, these eggs hatch out into worm-like creatures called larvæ (sing. larva). The larvæ have biting mouth parts and feed on the drug making it unsightly. If not combatted, they may travel from one box, drawer, package or can to another and in time cause wholesale destruction. After a time each larva develops into a pupa and then into an imago or winged adult. All of these stages may be passed inside of one container and several generations or broods may be reared, until the drug is eventually reduced to debris.

Probably the most common drug infesting beetle is *Sitodrepa panicea*, a member of the *Plinidæ* family.

It possesses a brown colored, subcylindrical body, rounded at anterior and posterior ends, with head nearly concealed by prothorax and with striated wing covers (elytra). Its length is from 2 to 3 mm. The larva of this insect is characterized by a brown head with strong

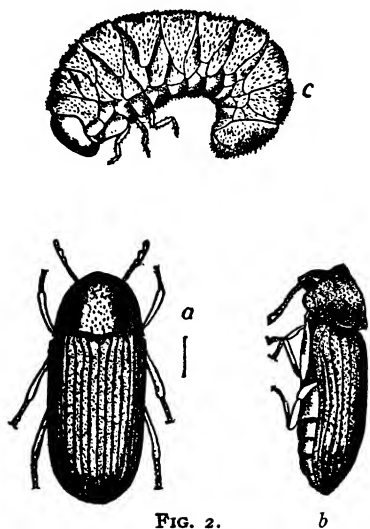


FIG. 2.

b

FIG. 2.—*Sitodrepa panicea* Linné. The common drug-eating insect. *a*, Dorsal view of adult beetle. *b*, Side view of adult beetle. *c*, Larva. (Sayre after Smith.)

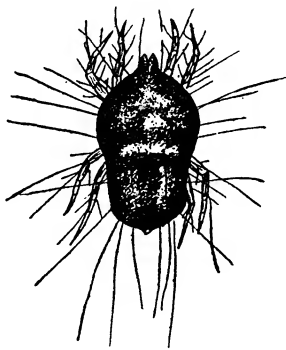


FIG. 3.

FIG. 3.—A Cantharid-eating Mite (*Glyciphagus spinipes*). (Sayre after Fum. and Rob.)

jaws (mandibles) and a white abdomen. It channels its way through the drug leaving evidences of its presence in the form of holes. In the course of a couple of weeks it changes to a pupa which soon develops into an adult beetle that also feeds upon the drug. I have found this insect in specimens of most of the spices, in black hellebore, aconite, belladonna, poke, angelica, marshmallow and parsley roots, in scopola and in wheat middlings.

Another drug ravaging beetle, *Lasioderma serricornis*, has a somewhat similar appearance to the preceding species but is larger and broader with smooth elytra. It has been found to attack spices and tobacco. Other beetles responsible for considerable damage are the spider beetles, *Plinus brunneus*, *Niptus hololeucus*, *Calandra granaria* (a granary weevil), and *Lyctus brunneus* (powder-post beetle).

The most prevalent drug attacking moth is the corn meal moth, *Tinea zea*. In its larva (caterpillar) stage it has been found in ergot, flaxseed, the *Compositæ* root drugs such as dandelion and burdock, in aconite, as well as many other drugs and cereals. A member of the fly and mosquito order (*Diptera*), namely, *Trypeta arnicivora* lays its eggs on the receptacles of European Arnica flowers before they are gathered. These eggs frequently hatch out in the drug later and, feeding on it, do considerable damage.

A number of animal products and cereals are subject to attack by *mites*. Mites differ mainly from insects in not being differentiated, as to their bodies, into distinct head, thorax and abdomen, and in possessing in their fully developed condition eight legs instead of six. Several species of the mite genus, *Glyciphagus*, have been commonly found in Cantharides. Their presence is indicated when powder and fragments of the whole drug and minute, motile, white specks are observed in the container.

The most effective means of ridding crude drugs of eggs, larvæ and adult insects is to expose them to a temperature of 60°C. for a period varying from 15 minutes for small quantities to two or three days for supplies in large store rooms.

A practical means of combatting insects and mites in crude drugs kept on a small scale is to keep them in air-tight tin cans or jars into which a few drops or more (depending on the size of the container) of carbon tetrachloride or chloroform are introduced from time to time. About 1 cc. for each 4 cubic feet of drug is sufficient for each treatment. At least two treatments of each new lot of drug with either of these insecticides is essential, if any degree of success is to be attained. The first treatment will kill any larvæ present in the container, but it should be known that the vapors of these insecticides will not penetrate the eggs. A second treatment in the course of about a week or two, after the remaining eggs have had time to hatch out, generally insures against the depredations of these pests. A third treatment in the course of another week or two will insure the effectiveness of the remedy with a certainty.

Tar camphor may be used effectively in the preservation of Cantharis, Coccus and other dried animal drugs.

Paradichlorobenzene has recently been found both convenient and effective in removing all traces of insect life from crude drugs in containers and from herbarium cabinets. A half ounce for each cubic foot of container space is adequate and one treatment suffices for each lot provided it is not subsequently exposed to insect attack. But it can only be recommended for museum or display specimens on account of the odor it imparts to the stored materials.

*Molds* are apt to attack fleshy rhizomes, roots, corms, and bulbs as well as various leaf and herb drugs. Their spores are constantly present in the atmosphere and only require the presence of moisture and warmth in order to germinate and grow into hyphæ. These hyphæ or mold filaments penetrate the drug and in time form a mycelium which appears as a whitish or colored intertangled mass of hyphal threads. The protoplasm of every mold secretes enzymes which not only digest and dissolve the cellular tissue of the drug but alter its



constituents and make it in time worthless. To insure against mold attack all vegetable drugs should be carefully dried and stored in dry containers in a cool room.

*Rusts* occasionally attack leaves or herbs before they are collected. They are parasitic plants whose spores form hyphæ in the presence of moisture and warmth that ramify through the intercellular-air-spaces of the host and send branches into the cells. These secrete enzymes which alter the constituents present. The presence of rusts may often be detected by their brownish or reddish fruiting bodies which appear on the surface of the drug. *Malvæ Folia* is more apt to contain considerable rust infested material than any other drug concerning which the writer is aware. In this case *Puccinia malvacearum* is the fungus responsible, producing brownish fruiting bodies on many of the leaves. All rust infested material should be rejected before the drug is stored or used in any way.

Yeasts, bacteria and molds all secrete enzymes which destroy or alter constituents, and have the ability to develop in the presence of moisture, air and warmth. Vegetable drugs, therefore, should be kept in dry air-tight containers and in a cool room, if they are to be kept in good condition. All cellular vegetable drugs should be perfectly dry before they are stored.

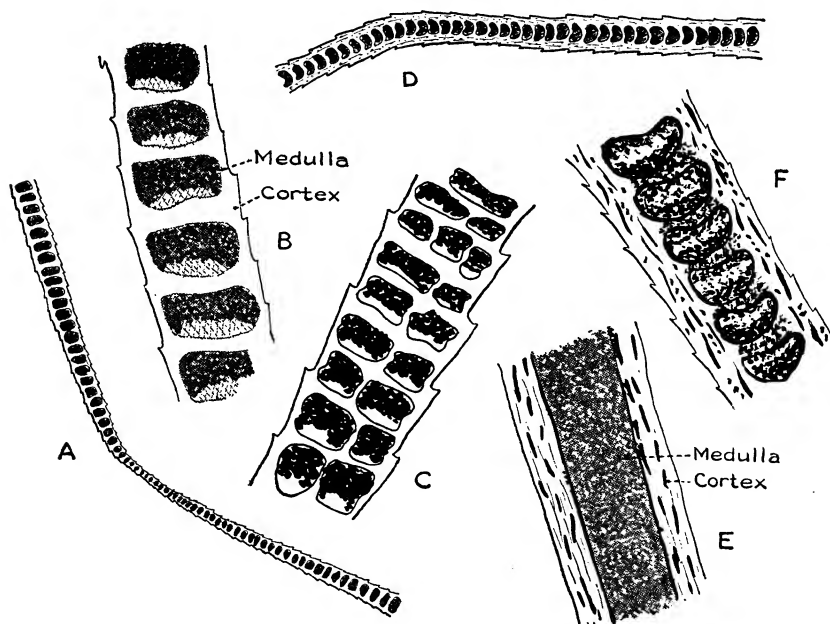


FIG. 4.—Rodent and cat hairs found in animal excreta occurring in vegetable drugs kept under unsanitary storage conditions. A, Portion of rodent hair. B, Rodent fur hair segment (high power magnification), showing single-rowed, discontinuous medulla, and narrow, non-pigmented cortex. C, Rodent guard hair, showing multiple-rowed, discontinuous medulla. D, Cat fur hair (low power magnification). E, Cat guard hair (high power magnification), showing continuous medulla and pigmented cortex. F, Cat fur hair (h.p.), showing single-rowed discontinuous medulla, and broad pigmented cortex. (Drawing by R. W. Vander Wyk.)

Apart from the influence of temperature on the development of bacteria and fungi, it should be remembered that it bears a direct relation to the quality of many drugs. All drugs, for instance, containing volatile principles are deleteriously influenced by being dried or stored at the higher temperatures. Care should therefore be exercised in drying these slowly at moderate temperatures and in storing them in air-tight containers, in a room having a fairly uniform cool temperature.

**Animal Excreta.**—Crude drugs, spices, cereals and various other food products have sometimes shown evidences of contamination with filth in the form of rodent and cat excreta from unsanitary storage conditions. Such may be ascertained by the presence of small rodent pellets of variable shape with a mucus-like coating and containing embedded rodent hairs and cat feces containing embedded cat hairs. The material may show the presence of urine voided by mice, rats or cats. Urine may be suspected by noting fluorescence under filtered ultra violet light and confirmed by obtaining a positive test for urea. The two main diagnostic types of hairs found on the bodies of rodents, cats and other animals are the *guard* or *top hairs* and the *fur* or *under hairs*. The guard hairs are coarse and heavy in texture, the under or fur hairs, soft and fine. The hair is covered with an epidermis or cuticle consisting of overlapping scales beneath which is a cortex or fiber-layer whose cells may contain pigment granules and, beneath the cortex, a central medulla of loosely arranged to compact cells or hollow. Some of the differences between rodent hairs and cat hairs are, as follows: (1) The internodes of many rodent hairs including those of the common house mouse and brown rat are usually very prominent whereas those of the cat hairs are less pronounced, usually indistinct. (2) The cortex of rodent hairs shows sparsely scattered pigment granules whereas that of cat hairs shows large numbers of pigment granules. (3) The medulla of the guard hairs of rodents is multiple rowed and discontinuous whereas the medulla of guard hairs of cats is continuous. (4) The medulla of the fur hairs of both rodents and cats is single rowed and discontinuous. (5) The medullary segments of rodent hairs are usually elongated in the direction of hair elongation whereas those of cat hairs are usually broader than long. (6) The medullary cells of rodent fur hairs, if pigmented, are compactly pigmented with the compacted pigment either in one end of the cell or in the center and the pigment granules are black or very dark brown, whereas the medullary segments of cat fur hairs, if pigmented are loosely pigmented and the color of the pigment granules is usually brown or reddish brown. (7) The guard hairs of rodents possess cuticular scales which are ovate, ovate-elongate to flat along the edge, those of the rat, prominently pointed, whereas those of cats are crenate to flat along the edge.

**Historical.**—The word "Pharmacognosy" (Gr. *Φάρμακον*, drug, poison or medicine + *γνώσις*, knowledge) was introduced by Seydler in 1815 and literally translated means the science of drugs or medicines. If we consider that up to the last 60 or 75 years it was customary for pharmacists, physicians and others to collect drugs directly from plants in the field and so required of these more of a knowledge of the characteristics of living medicinal plants than of their



ailments, the symptoms of diseases and diagnosis, action of the heart and blood vessels, the treatment of wounds and sores together with some folk lore.

The ancient Greeks were familiar with a number of drugs in use to-day. Pythagoras (B.C. 582), a Greek philosopher, was acquainted with mustard and squill and Hippocrates (B.C. 466), a Greek physician, with absinthium, cinnamon, conium, gentian, hyoscyamus, rhubarb, acacia, myrrh, chamomile and many others. Theophrastus (B.C. 372), a pupil of Aristotle, wrote ten books "On the History of Plants" and eight "On the Causes of Plants." He was familiar with ergot, pepper, opium, aspidium and cinnamon. He was followed by Alexander the Great who founded Alexandria and made it a seat of learning. Alexander made a number of expeditions into Africa, Persia and India and brought back new drugs which he introduced into the medicine of Greece.

Pedanius Dioscorides, a Greek physician, who lived in the first century B.C. was the first to write extensively on medicinal plants. His great work "De Materia Medica," written in 77 or 78 B.C., treats of all the medicinal substances then known and of their properties. Several thousand of these he described in detail. During fifteen centuries his work was the authority in botany and materia medica.

The Roman Empire rose following the death of Alexander the Great and played an important role in the progress of pharmacy and medicine.

Pliny, the Elder (23-79 A.D.), a Roman soldier and writer, wrote 47 large volumes on natural history which contained information on about 1000 plants. While his works treat extensively with fabled monsters, they were, nevertheless, considered authoritative during the middle ages. Henna, cassia, piper, linum, anise, aspidium and other drugs still in use are mentioned in his writings. Galen (131-200 A.D.), a Greek pharmacist and physician, wrote 20 books containing numerous formulae for preparations. He noted in his writings the adulteration of saffron, myrrh, cinnamon and rhubarb.

From the fifth to the fifteenth centuries little advance was made in pharmacognosy and other sciences. The Roman Empire which had reached its zenith in productivity during the Age of Augustus, declined and in 476 A.D. fell, as the result of the conquest of Rome by the Germanic tribes. The Arabians carried forward the scientific advances of the Greeks and Romans but contributed comparatively little of their own. In pharmacognosy, the most notable of these were Avicenna, Rhazes, Mesue Senior and Baitar.

Avicenna (837 A.D.), an eminent physician and philosopher, wrote "Canon Medicinæ" which became the leading medical work down to the fifteenth century. Rhazes (873) who was head of a Bagdad hospital and author of pharmaceutical works was acquainted with aloes, asafetida, hyoscyamus, stavesacre, taraxacum, etc. Mesue Senior (777-857) wrote a pharmaceutical formulary and introduced senna, tamarind, cassia fistula and jujube. Ibn Baitar (1197-1248), a physician of Malaga, contributed an extensive treatise on materia medica entitled "Liber magnæ collectionis simplicium alimentorium et medicamentorum." This work contains much of value on the economic plants of the East.

In 1530, 1531 and 1536, Otto Brunfels, a German botanist and physician, published three volumes entitled "*Herbarum Vivæ Icones*," which contained 229 woodcuts of plants and was famed for having been the first work to contain good botanical illustrations. Brunfels was also the first to write on local floras and to describe the native plants of Germany and as such is regarded by many as the "father of botany."

Valerius Cordus (1515-1544), Professor of materia medica at the University of Wittenberg, wrote several papers on medicinal plants which were published after his death by Conrad Gesner in 1561, at Strassburg. This publication is a large volume which not only contains the papers of Cordus (*Historiæ stirpium*, etc.) but also a treatise, "*De Hortis Germaniæ*" by Gesner himself.

In 1573, Garcia da Orta, a Portuguese scientist issued his "*Colloquies*," a valuable treatise on the drugs of India.

In 1737, Carl von Linné (Linnæus) (1707-1778) a Swedish botanist, published his "*Genera Plantarum*" which was considered the starting point of systematic botany. Linnaeus published a number of works dealing with botany and zoology, but by far his most notable accomplishment was his "*Species Plantarum*." This work appeared in 1753 and includes a lengthy list of species of plants together with their descriptions and classification, according to a natural system, based upon a study of the resemblances and differences of their sexual organs. To Linnaeus belongs the credit of having brought order and system out of chaos, for his "*Species Plantarum*" is regarded by all modern botanists as the starting point of Systematic Botany, and his binomial system of nomenclature therein introduced is followed by all naturalists of note even to the present day.

In 1816, morphine was discovered in opium by Friederich Wilhelm Adam Sertürner, an apothecary of Einbeck, in Hanover, Germany, who demonstrated its poisonous character and prepared a number of its salts. This discovery led probably more than any other to changing the focus of scientists from drug plants to crude drugs and their contents.

In 1820, Guibourt, a Frenchman, of Paris issued a valuable treatise entitled "*Historie Naturelle des Drogues Simples*" which passed through several editions.

Modern Pharmacognosy may be said to begin with the work of Theodor W. C. Martius, an apothecary of Erlangen, Germany. Martius conducted a series of investigations on drugs, publishing some of his results in 1825 and all of them in 1832, in a book entitled, "*Grundriss der Pharmakognosie des Pflanzenreiches*." This was the first extensive treatise on Pharmacognosy written. In this work he conceived the scope of pharmacognosy as embracing the examination of medicinal substances derived from the three natural kingdoms with a view to ascertaining their source and quality, to test them for their purity and investigate their adulterants and substitutes. He classified the drugs morphologically.

In 1838, Histological Pharmacognosy had its beginning with the announcement by Mathias Jacob Schleiden, a German botanist, that the cell is the funda-

mental unit of plant structure and that all tissues are combinations of cells.

The following year Jonathan Pereira published, in London, a valuable work entitled "Elements of Materia Medica and Therapeutics."

In 1842, M. J. Schleiden, then a professor of Botany at Jena, wrote his most important work, "Grundzüge der Wissenschaftlichen Botanik." In this work he emphasized the inductive method of botanical research and sharply attacked the hazy, philosophical treatment of questions bearing on morphology. In 1857, he issued one of the early Pharmacognosies, entitled "Handbuch der Medicinisch-Pharmazeutischen Botanik und botanischen Pharmakognosie," which was published at Leipzig. He shows therein that drugs of different kinds must be determined by their cellular differences and he designated Pharmacognosy, on account of its exacting character, as "the mother of all scientific discipline."

In 1858, O. Berg, of Berlin, Germany, issued his "Pharmazeutische Waarenkunde" and in 1865 his "Anatomischer Atlas zur Pharmazeutischen Waarenkunde."

From this time on Pharmacognosy developed rapidly in Europe, largely due to the researches and publications of such scholars as Vogl, Wiegand, Wittstein, Behrens, Tunmann, Oesterle, Hoffman, Flückiger, Moeller, Hanausek, Meyer, Gilg, Karsten, Dragendorff and Wasicky of Germany and Austria, Tschirch and Zörnig of Switzerland, Baillon, Collin and Perrot of France, Holmes, Hanbury, Greenish, Wallis and Trease of England, and Ferdinand von Mueller in Australia.

Among the works of these scientists the following should be consulted by all who seek an intimate acquaintanceship with the cream of foreign pharmacognostic classics:

"Pharmakognosie," by A. E. Vogl.

"Anatomischer Atlas zur Pharmakognosie," by A. E. Vogl.

"Lehrbuch der Pharmakognosie," by Albert Wiegand.

"Pharmakognosie des Pflanzenreiches," by G. C. Wittstein.

"Pharmakognosie des Pflanzenreiches," by F. A. Flückiger.

"Pharmacographia," by F. A. Flückiger and Daniel Hanbury.

"Lehrbuch der Physiopharmakognosie," by Richard Wasicky.

"Microscopy of Technical Products," by T. F. Hanausek and A. Winton.

"Pharmakognostischer Atlas," by Joseph Moeller.

"Lehrbuch der Pharmakognosie," by Joseph Moeller.

"Mikroskopie der Nahrungs und Genussmittel," by Joseph Moeller.

"Microscopy of Vegetable Foods," by Winton and Moeller.

"Lehrbuch der Pharmakognosie," by Ernst Gilg.

"Anatomischer Atlas," by Tschirch and Oesterle.

"Handbuch der Pharmakognosie," by Alexander Tschirch.

"Arzneidrogen," by Heinrich Zörnig.

"Traite de Toxicologie Vegetale," by Eugene Collin.

"Anatomical Atlas of Vegetable Powders," by Henry G. Greenish and Eugene Collin.

"Microscopical Examination of Foods and Drugs," by Henry G. Greenish.

"A Text Book of Materia Medica," by Henry G. Greenish.

"Anleitung zur Microchemischen Analyse," by H. Behrens.

"Grundriss einer Histochemie der Pflanzlichen Genussmittel," by Hans Molisch.

"Pflanzenmikrochemie," by Otto Tunmann.

"Microchemie der Pflanze," by Hans Molisch.

"Wissenschaftliche Drogen Kunde," by Arthur Meyer.

"Lehrbuch der Pharmakognosie," by G. Karsten and W. Benecke.

"Plantes médicinales de France," by Em. Perrot.

"Leitfaden für die Pharmakognostischen Untersuchungen," by R. Wasicky.

"A Text-book of Pharmacognosy," by G. E. Trease.

"Mikroskopie der Nahrungs- und Genussmittel aus dem Pflanzenreiche," by J. Moeller and C. Griebel.

"Practical Pharmacognosy," by T. E. Wallis.

In the United States, apart from work done on medicinal plants by Bartram, Carson, Millspaugh, and others, Pharmacognosy did not begin to develop to the standing of a distinct science until up to about 60 years ago.

Since that time it has advanced by leaps and bounds, largely due to the researches and publications of an increasing number of American investigators, including Maisch, Bastin, Rusby, Kraemer, Schlotterbeck, Wall, Schneider, Sayre, Culbreth, Gathercoal, Wirth, Ballard, Hart, Schwarz, Bonisteel, Zufall, Hocking, Viehoever, Clevenger, Ewing, Mansfield, Christensen, Hiner, Hoch, Sievers, Slama, Mollett, Darbaker, Fischer, Newcomb, Bacon and others. It is now recognized as a major study in the curriculum of every pharmaceutical institution of this country. The Pure Food and Drug Act of 1906, the adoption of microscopical descriptions for crude and powdered drugs in the subsequent revisions of the United States Pharmacopœia and National Formulary, as well as its practical usefulness to an increasing number of industries, gave wonderful impetus to its growth.

Some of the books written by American authors which bear upon one or more phases of the science are as follows:

"Organic Materia Medica," by John M. Maisch.

"American Medicinal Plants," by Charles F. Millspaugh.

"College Botany," by Edson S. Bastin (revised by W. B. Day).

"Introduction to Pharmacognosy," by Smith E. Jelliffe.

"Materia Medica and Pharmacology," by D. M. R. Culbreth.

"Organic Materia Medica and Pharmacognosy," by Lucius E. Sayre.

"Histology of Medicinal Plants," by William Mansfield.

"Squibb's Atlas of The Official Drugs," by William Mansfield.

"Manual of Botany," by Henry H. Rusby.

"Microanalysis of Powdered Vegetable Drugs," by Albert Schneider.

"A College Textbook of Pharmaceutical Botany," by Heber W. Youngken.

"Origin and History of Pharmacopœial Vegetable Drugs, etc.," by John Uri Lloyd.

"A Textbook of Pharmacognosy," by Heber W. Youngken.

"Materia Medica and Pharmacognosy," by Wm. Mansfield.

"Kraemer's Scientific and Applied Pharmacognosy," by Newcomb, Darbaker, Gathercoal and Fischer.

"Handbook of Pharmacognosy," by Otto A. Wall (revised by Leo Suppan).

"Materia Medica and Pharmacognosy," by H. C. Washburn and W. H. Blome.

"Pharmacognosy," by E. N. Gathercoal and E. H. Wirth.

"Structure and Composition of Foods," by A. L. Winton and K. B. Winton.

## CHAPTER II

### MORPHOLOGICAL CLASSIFICATION OF CRUDE DRUGS

#### VEGETABLE DRUGS

##### ROOTS

These represent descending axes of plants which are devoid of leaves.

#### A. Those official in the U.S.P. XIII.

TITLE	BOTANICAL ORIGIN	FAMILY
1. <i>Monocotyledonous</i> :		
Sarsaparilla	<div style="display: inline-block; vertical-align: middle;"> { <i>Smilax aristolochiæfolia</i> (S. medica)  <i>Smilax Regelii</i> (or certain undeter-  mined spp. of <i>Smilax</i>) </div>	} <i>Liliaceæ</i>

#### B. Those official in the N.F. VIII. All dicotyledonous.

<i>Althæa</i> (Marshmallow)	<i>Althæa officinalis</i>	<i>Malvaceæ</i>
<i>Belladonnæ Radix</i> (Deadly Nightshade Root)	<i>Atropa Belladonna</i>	<i>Solanaceæ</i>
<i>Bryonia</i> (Bryony)	<div style="display: inline-block; vertical-align: middle;"> { <i>Bryonia alba</i>  <i>Bryonia dioica</i> </div>	} <i>Cucurbitaceæ</i>
<i>Calumba</i> (Colombo)	<i>Jateorrhiza palmata</i>	<i>Menispermaceæ</i>
<i>Ipomœa</i> (Orizaba Jalap)	<i>Ipomœa orizabensis</i>	<i>Convolvulaceæ</i>
<i>Senega</i> (Seneca-snakeroot)	<i>Polygala Senega</i>	<i>Polygalaceæ</i>

#### C. Other medicinal roots.

<i>Alkanna</i> (Alkanet)	<i>Alkanna tinctoria</i>	<i>Boraginaceæ</i>
<i>Asclepias</i> (Pleurisy Root)	<i>Asclepias tuberosa</i>	<i>Asclepiadaceæ</i>
<i>Baptisia</i> (Wild Indigo)	<i>Baptisia tinctoria</i>	<i>Leguminosæ</i>
<i>Krameria</i> (Rhatany)	<div style="display: inline-block; vertical-align: middle;"> { <i>Krameria triandra</i>  <i>Krameria argentea</i> </div>	} <i>Leguminosæ</i>
<i>Lappa</i> (Burdock)	<div style="display: inline-block; vertical-align: middle;"> { <i>Arctium Lappa</i>  <i>Arctium minus</i> </div>	} <i>Compositæ</i>
<i>Manaca</i>	<i>Brunfelsia Hopeana</i>	<i>Solanaceæ</i>
<i>Muirea Puama</i>	<i>Liriosma ovata</i>	<i>Oleaceæ</i>
<i>Pareira</i> (Pareira Brava)	<i>Chondodendron tomentosum</i>	<i>Menispermaceæ</i>
<i>Petroselinæ Radix</i> (Parsley Root)	<i>Petroselinum crispum</i>	<i>Umbelliferæ</i>
<i>Phytolacca</i> (Poke Root)	<i>Phytolacca americana</i>	<i>Phytolaccaceæ</i>
<i>Pellitory Root</i>	<i>Anacyclus Pyrethrum</i>	<i>Compositæ</i>
<i>Rumex</i> (Dock)	<div style="display: inline-block; vertical-align: middle;"> { <i>Rumex crispus</i>  <i>Rumex obtusifolius</i> </div>	} <i>Polygonaceæ</i>
<i>Scammoniæ Radix</i> (Levant Scammony Root)	<i>Convolvulus Scammonia</i>	<i>Convolvulaceæ</i>
<i>Stillingia</i> (Queensroot)	<i>Stillingia sylvatica</i>	<i>Euphorbiaceæ</i>

In the examination of root drugs the physical characteristics, including occurrence, size, shape, color, surface markings, fracture, internal appearance, odor, and taste are first taken into consideration.



**Occurrence.**—Roots *occur* either in the entire or nearly entire condition, as Senega, Stillingia, Pellitory, or as longitudinal slices, in some specimens, as Althæa, Belladonna, and Lappa, or as transverse and oblique slices, as in Calumba and Bryonia, or in small cubical pieces, as in some specimens of Althæa, or as peeled, broken or longitudinally sliced roots, as in other specimens of Althæa, or as bales of rootlets, as in Sarsaparilla.

**Size.**—The *size* of the root includes a consideration of length and diameter, and is stated usually in terms of centimeters (cm.) and millimeters (mm.).

**Shape.**—In the consideration of *shape*, the general outline or form of the root is observed. This may be *conical*, as in Aconite; *fusiform*, as in Stillingia; *cylindrical*, as in Sarsaparilla; *disk-like*, as in Calumba and Bryonia; *simple*, as in Pellitory; *branched*, as in Krameria and Senega; *twisted*, as in Scammonia Radix; etc.

**Surface Markings.**—The surface markings of roots may be of the nature of scars, furrows, wrinkles, annulations, nodules, fissures or abrasions. When roots exhibit more or less parallel well defined ridges and depressions, as in Mexican and Central American Sarsaparillas and Scammony root, they are *furrowed*; when the furrows are less defined, as in Baptisia, they are *wrinkled*; when transverse, ring-like outgrowths are evident, as in Ipecacuanha and Petroselin Radix, they are *annulated*; when openings occur running into the tissues, as in Ipecac and Savanilla Krameria, they are *fissured*; when more or less rounded outgrowths occur on the surface, as in Muira Puama, they are *nodulated*; when portions of the outer tissues are rubbed off, as in Belladonna Root, they are *abraded*.

**Fracture** has to do with the way a root or other plant part breaks when subjected to enough pressure. The fracture of most official roots is *complete*, since they break clean across. That of Sarsaparilla and Aralia is *incomplete*, since both of these break only part way across. The terms *short*, *brittle*, *fibrous*, *horny*, *strongly* or *slightly*, etc., are used to describe the nature of complete or incomplete fractures. To these are frequently added the terms *even*, *uneven*, *starchy*, *resinous*, *conchoidal*, etc., in order to describe the nature of the fractured surface.

Those roots which are too tough to be fractured are *breakable*, as Pareira, Ipomœa, and the thicker pieces of Krameria and Asclepias.

**Internal Appearance.**—After the root has been broken or fractured, its *internal characteristics* should be observed. In respect to this, it is necessary to observe the color and other characters of cortex, wood, cambium, and, in the case of Monocotyl roots, the nature of the endodermis and stele.

The ratio in diameter of bark to wood should be observed as well as the color and markings of each of these regions. In Monocotyl roots it is essential to note the ratio in diameter of cortex and central cylinder or *stele*.

**Odor and Taste.**—Attention to odor and taste is particularly important in determining the quality of drugs.

The *odor* of a drug is either *distinct* or *indistinct*. It is distinct in the vast majority of root drugs. In such roots as Asclepias, Krameria, Phytolacca,

and Sarsaparilla, it is indistinct. The distinctness of the odor of a drug bears a direct relation to the volatile constituents it possesses. The term "characteristic" is employed to qualify an odor or taste which has not been correlated with that of any other substance in nature.

The *taste* of a drug may be *simple*, when it has but one taste, as *Krameria*, which is astringent. Whenever more than one taste sensation is imparted by a drug, as for example *Aconite*, which is successively sweet, acrid, tingling and numbing, the taste is described as *complex*.

**Histology.**—Following a study of the physical characteristics, an inquiry into the microscopic structure of the root drug is made. In many instances the examination of transverse sections suffices to identify the drug. But in no case is the inquiry complete without the examination of longitudinal-radial and longitudinal-tangential sections.

All roots of Monocotyledons used as drugs are characterized by showing primary root structure and a polyarch, radial fibrovascular bundle. The official Dicotyledonous root drugs all show secondary root structure and so possess secondary cortex, one or more circles of open collateral bundles, but no pith, *Aconite* excepted. Protoxylem occupies the center in all normal dicotyl roots of secondary growth. The thin rootlets emanating as branches from the main drug root often exhibit primary dicotyl root structure, showing the following regions from periphery toward the center: Epidermis, primary cortex, endodermis, pericambium, a radial fibrovascular bundle and pith.

The study of the powdered root is next taken up. **Powdered roots** are characterized by the absence of mesophyll and stomata, the presence of cork or epidermal tissue, fibrovascular elements and ordinary parenchyma. Stone cells and laticiferous tissue may or may not be present.

### TUBEROUS ROOTS

These are roots which are swollen for food storage and which show anomalous internal structure. Swollen (tuberous) primary roots occur in the beet, carrot and aconites. Swollen secondary roots occur in *Asafetida* plants and other *Umbelliferae*, in the yams, *Dioscorea* spp., etc. Tuberous adventitious roots occur in *Jalap*, Sweet Potato (*Ipomæa Batatas*) and many orchids. See part II.

TITLE	BOTANICAL ORIGIN	FAMILY
Aconitum (Monkshood), N.F.	Aconitum Napellus	Ranunculaceæ
Jalapa (Jalap Root), N.F.	Exogonium purga	Convolvulaceæ

### TUBERS

These are short, thick and solid underground stems borne usually at the end of slender creeping branches.

The tubers of the potato, *Solanum tuberosum*, serve as excellent types for preliminary study. These either arise from the ends of stolons borne from the lower region of the aerial stem, when the plant is grown from seed, or from the

ends of long slender rhizomes (arising from underground axillary buds on the tuber) when the potato tuber is used as a cutting in propagation.

The **potato tuber** is an enlarged, fleshy underground stem covered on its exterior by a periderm of cork. At one end will be noted a terminal bud and scattered over the surface will be seen depressions containing groups of *lateral axillary buds* or "*eyes*" which are somewhat spirally arranged, also scattered lenticels. If a portion containing an "eye" be planted, the bud will give rise to a slender rhizome bearing a tuber on its end. Upon halving the potato, it will be noted that the cut surface shows an outer brown *periderm* or *cork* zone, a relatively narrow *cortex*, a dark *vascular ring* near the edge, consisting of a discontinuous circle or ellipse of bundles, and a very broad *medulla* of starch-parenchyma. It will be observed that the vascular bundles approach the surface at the eyes. The medulla is divided into two regions, viz., the *external* and *internal medulla*. These can be readily distinguished by holding a thin transverse slice of the tuber up to the light, when the external medulla appears darker, denser and more starchy. The internal medulla is irregularly star-shaped and some of its arms penetrate the outer tissues as far as the eyes.

Potatoes are used chiefly as human food, stock food, and for the production of commercial potato starch and some alcohol.

**Potato starch** is prepared by soaking the potatoes in water, washing them, reducing them to pulp in rasping machines, passing the pulp through copper sieves which separates the fiber from the liquid containing the starch, allowing the liquor to stand, the starch settling to the bottom of the container. The starch is drawn off and purified by permitting it to run over sloping tables, the starch grains settling while the protein or gluten being lighter passes off. The starch is then removed and dried.

## RHIZOMES

**Rhizomes** are creeping underground stems of horizontal, vertical or oblique growth.

### A. Those official in the U.S.P. XIII.

TITLE	BOTANICAL ORIGIN	FAMILY
1. <i>Fern rhizome and stipes:</i>		
Aspidium	{ <i>Dryopteris Filix-mas</i> <i>Dryopteris marginalis</i>	{ <i>Polypodiaceæ</i>
2. <i>Monocotyledonous rhizome:</i>		
Zingiber (Ginger)	<i>Zingiber officinale</i>	<i>Zingiberaceæ</i>

### B. Those official in the N.F. VIII.

1. <i>Monocotyledonous:</i>		
Calamus (Sweetflag)	<i>Acorus Calamus</i>	<i>Araceæ</i>
Iris (Orris)	{ <i>Iris germanica</i> <i>Iris florentina</i> <i>Iris pallida</i>	{ <i>Iridaceæ</i>
2. <i>Dicotyledonous:</i>		
Sanguinaria (Blood Root)	<i>Sanguinaria canadensis</i>	<i>Papaveraceæ</i>

## C. Other medicinal rhizomes.

TITLE	BOTANICAL ORIGIN	FAMILY
1. <i>Monocotyledonous</i> :		
Dioscorea (Wild Yam)	Dioscorea villosa	Dioscoreaceæ
Galanga (Galangal)	Alpinia officinarum	Zingiberaceæ
Iris Versicolor (Blueflag)	{ Iris versicolor Iris virginica	{ Iridaceæ
Zedoaria (Zedoary)	Curcuma Zedoaria	Zingiberaceæ
2. <i>Dicotyledonous</i> :		
Geranium (Cranesbill)	Geranium maculatum	Geraniaceæ
Bistorta (Serpentary)	Polygonum Bistorta	Polygonaceæ

In the examination of rhizomes, the physical characteristics are first to be noted. These should include occurrence, size, shape, direction of growth, external color, surface markings (including stem and leaf bases and scars), fracture, internal appearance, odor and taste.

Rhizomes occur either in the entire condition as Geranium; or in broken pieces as in Dioscorea, Zingiber, Iris, Iris Versicolor and Galanga; or in transverse slices as Zedoaria; or in longitudinal slices as some specimens of Iris Versicolor. Iris, Calamus, and some varieties of Zingiber are peeled or partially peeled. Calamus occurs in the peeled and unpeeled condition. All of the official rhizomes tend to be branched. They all grow in a horizontal direction except Aspidium which has oblique growth.

The surface markings of rhizomes include annulations from the bases of bud scales which have withered, leaf scars, stem scars, root scars and wrinkles, the last due to the contraction of the tissues in the drying process. In addition to these, Aspidium shows numerous curved stipe bases.

The fracture of the rhizomes varies from short, brittle and even in Zedoaria, and Aspidium to short, tough and even in Dioscorea, Iris and Geranium to strongly tough and uneven in Galanga to short, brittle and uneven in Iris Versicolor and Zingiber.

In the study of the internal appearance, width and color of bark or of cortex and central cylinder, bundle markings, prominence of endodermis and relative diameter of pith are taken into consideration. All of the above rhizomes excepting Aspidium, Bistorta and Geranium, show scattered bundle markings in the central cylinder or stele. There is something diagnostic in the microscopic appearance of the fractured or cut surface of each of the medicinal rhizomes. Thus, Aspidium is green and shows an interrupted circle of xylocentric bundles; Zingiber shows scattered oil cells with yellowish, occasionally brown or reddish contents and a pale yellow endodermis; Dioscorea has a yellowish-white to pale yellowish 'orange appearance and shows numerous scattered yellow bundles; Zedoaria shows a thick grayish yellow cortex, separated from the very broad, grayish-brown stele by a light colored endodermis; in both cortex and stele will be noted numerous scattered, small brown spots, representing the contents of resin cells; Galanga shows an orange-brown broken surface with endodermis indistinct; Iris is yellowish-white to weak yellowish-orange, shows a narrow cortex, prominent endodermis and broad stele; Iris Versicolor resembles Iris

but its internal color is dusky red to pale orange; Trillium has numerous brownish root scar markings in its thick cortex; Geranium has a thin bark, distinct cambium and broad pith, and its color is light purple-brown.

The odor of *Iris Versicolor*, *Dioscorea*, *Aspidium* and *Geranium* is indistinct; that of *Iris* resembles violets; that of *Zedoaria* is camphor-like; that of the remainder is aromatic and distinctively characteristic.

The taste varies from aromatic and pungent in *Zingiber*, to aromatic, pungent and pepper-like in *Galanga*, to acrid in *Iris* and *Iris Versicolor*, to starchy and acrid in *Dioscorea*; to strongly astringent in *Geranium* and *Bistorta*.

**Histology.**—Following the study of the physical characteristics, a study of the microscopical features should be undertaken, in order to prepare one not only to identify the drug from a small portion of the organ and to detect adulterants but to know what to expect in the study of the powdered drugs. This is applicable in the case of every crude drug representing a plant organ.

All of the official rhizomes excepting *Aspidium* exhibit Monocotyl stem structure. In the examination of Monocotyl rhizomes the following tissue regions are to be studied:

1. Epidermis
2. Cortex
3. Endodermis
4. Central Cylinder or Stele.

As in aerial stems of Monocotyledons, fibrovascular bundles of the closed collateral or concentric type will be noted scattered throughout central cylinder and cortex regions. Some of these, namely the main rhizome bundles, run nearly straight but others, which course out toward leaves and roots, run obliquely or transversely. In rhizomes, where the nodes are closely approximated, relatively few straight or nearly straight bundles are encountered.

Epidermis is usually the outermost tissue, but in rhizomes of the *Zingiberaceæ* including *Zingiber*, *Zedoaria* and *Galanga*, cork arises in the subjacent cortex and so, in older portions of these, may be seen entirely replacing epidermis.

The parenchyma of the cortex and central cylinder should be particularly examined in respect to the nature of cell walls and cell contents. In many instances diagnostic starch grains or crystals will be found. Scattered through this tissue may often be found secretion sacs with suberized walls and oleoresin contents, as in the *Gingers*, *Zedoary* and *Galangal*.

The nature of the thickenings of the endodermal cells should be observed as should also the markings on the walls of tracheæ and sclerenchyma fibers.

*Aspidium* is characterized microscopically by exhibiting both in its rhizome and stipe portions an interrupted circle of concentric bundles of the xylocentric variety, each of which shows a central xylem composed for the most part of tracheids of the scalariform type and a phloem which completely envelops the xylem. Surrounding the bundle, in each instance, is a 1- to 3-layered pericycle and a brownish endodermis or bundle sheath of a single layer of cells. In this

drug, also, internal glands containing a greenish oleoresin are to be noted, projecting into the intercellular-air-spaces.

Geranium exhibits dicotyl stem structure and so shows the following regions: (1) cork, (2) cork cambium, (3) cortex, (4) fibrovascular bundles of the open collateral type arranged in a circle, connected by interfascicular cambium and separated by medullary rays, and (5) pith. Particularly diagnostic of this drug are the numerous colored tannin masses in the parenchyma of the cortex and pith, the abnormal development of the interfascicular cambium, showing several patches of soft bast on its outer face in each medullary ray region, the presence of rosette aggregates in various cells of the cortex, and the absence of sclerenchyma fibers.

### RHIZOMES AND ROOTS

#### A. Those official in the U.S.P. XIII.

TITLE	BOTANICAL ORIGIN	FAMILY
2. <i>Dicotyledonous</i> :		
Gentiana (Gentian)	<i>Gentiana lutea</i>	Gentianaceæ
Glycyrrhiza (Licorice Root)	{ <i>Glycyrrhiza glabra</i> var. <i>typica</i> , <i>Glycyrrhiza glabra</i> var. <i>glandulifera</i> and other var. of <i>G. glabra</i>	{ Leguminosæ
Ipecacuanha (Ipecac)	{ <i>Cephaëlis Ipecacuanha</i> <i>Cephaëlis acuminata</i>	{ Rubiaceæ
Rheum (Rhubarb)	{ <i>Rheum officinale</i> , <i>R. palmatum</i> Other spp. (excepting <i>R. Rhaponticum</i> ) and hybrids of <i>Rheum</i> grown in China and Thibet	{ Polygonaceæ

#### B. Those official in the N.F. VIII.

1. <i>Monocotyledonous</i> :		
Convallaria (Lily-of-the-Valley Root)	<i>Convallaria majalis</i>	Liliaceæ
Triticum (Couchgrass)	<i>Agropyron repens</i>	Gramineæ
Veratrum Viride (American Hellebore)	<i>Veratrum viride</i>	Liliaceæ
2. <i>Dicotyledonous</i> :		
Apocynum (Black Indian Hemp)	{ <i>Apocynum cannabinum</i> <i>Apocynum androsæmifolium</i>	{ Apocynaceæ
Aralia (Spikenard)	<i>Aralia racemosa</i>	Araliaceæ
Caulophyllum (Blue Cohosh)	<i>Caulophyllum thalictroides</i>	Berberidaceæ
Cimicifuga (Black Cohosh)	<i>Cimicifuga racemosa</i>	Ranunculaceæ
Echinacea (Purple Cone Flower)	{ <i>Echinacea pallida</i> <i>Echinacea angustifolia</i>	{ Compositæ
Gelsemium (Yellow Jasmine)	<i>Gelsemium sempervirens</i>	Loganiaceæ
Hydrastis (Goldenseal)	<i>Hydrastis canadensis</i>	Ranunculaceæ
Leptandra (Culver's Root)	<i>Veronicastrum virginicum</i>	Scrophulariaceæ
Podophyllum (Mandrake)	<i>Podophyllum peltatum</i>	Berberidaceæ

TITLE	BOTANICAL ORIGIN	FAMILY
Serpentaria (Virginia Snakeroot) (Texas Snakeroot)	{ Aristolochia Serpentaria Aristolochia reticulata	{ Aristolochiaceæ
Taraxacum (Dandelion)	{ Taraxacum officinale Taraxacum lævigatum	{ Compositæ
Valeriana (Setwall)	Valeriana officinalis	Valerianaceæ

### C. Other medicinal rhizomes and roots.

#### 1. *Monocotyledonous*:

Aletris (Unicorn Root)	Aletris farinosa	Liliaceæ
Cypripedium (Lady's Slipper)	{ Cypripedium Calceolus var. pu- bescens	{ Orchidaceæ
Helonias (False Unicorn Root)	Chamælorium luteum	Liliaceæ
Trillium (Bethroot)	Trillium erectum et al. spp.	Liliaceæ

#### 2. *Dicotyledonous*:

Angelica Radix (Archangel Root)	{ Angelica Archangelica et al. spp. of Angelica	{ Umbelliferæ
Aralia Nudicaulis	Aralia nudicaulis	Araliaceæ
Asarum (Canada Snakeroot)	Asarum canadense	Aristolochiaceæ
Berberis (Barberry)	{ Spp. of Section Mahonia of genus Berberis	{ Berberidaceæ
Derris (Tuba Root)	{ Derris elliptica Derris malaccensis	{ Leguminosæ
Hydrangea (Seven-barks)	Hydrangea arborescens	Saxifragaceæ
Inula (Elecampane)	Inula Helenium	Compositæ
Kava (Methysticum)	Piper methysticum	Piperaceæ
Rhizoma Arnicae	Arnica montana	Compositæ
Spigelia (Pink Root)	Spigelia marilandica	Loganiaceæ
Sumbul (Musk Root)	{ Ferula Sumbul and closely related spp. of Ferula	{ Umbelliferæ

The physical characteristics and microscopical features of rhizomes and roots should be studied as to the various points indicated under the heading of "Roots" and "Rhizomes."

Since there are instances among the dicotyledonous drugs of this group, as in *Gentiana*, *Apocynum* and *Echinacea*, where the drug often consists of short separate pieces of rhizomes and of roots, it is often necessary to examine the cut surface to determine which of these organs one is dealing with. The presence of pith in the center of the piece examined always indicates rhizome and its absence, root.

Many of the drugs of this class have characteristic stem scars or stem bases as in *Podophyllum*, *Cimicifuga*, *Caulophyllum*. Others as *Veratrum*, *Aletris* and *Helonias* have characteristic leaf bases. *Taraxacum* shows a multiple crown. In *Serpentaria* leaves frequently occur with the rhizomes and roots.

As to the direction of growth, the majority are horizontal; a few as *Veratrum Viride*, *Taraxacum*, *Angelica*, *Valeriana* and *Gentiana* are vertical; *Aralia* and *Helonias* are oblique. The vertical rhizome and root drugs show characteristic

annulated outer surfaces in respect to their rhizomes. In *Taraxacum* and *Gentian* the upper portion of the drug is rhizome and the lower portion root.

### BULBS

**Bulbs** are short, vertical, subterranean stems covered with numerous fleshy scales, the latter comprising their greater bulk. A bulb is said to be "*tunicated*" when the fleshy scales surround each other in concentric fashion, completely sheathing the shortened stem, as in squill, onion, narcissus, etc. A bulb is called "*imbricated*" or "*scaly*" when its fleshy scales are narrow, flattened and arranged in rows, the outer ones overlapping the inner, as in the lilies.

#### A. Official in the N.F VIII.

TITLE	BOTANICAL ORIGIN	FAMILY
Scilla (Squill)	{ <i>Urginea maritima</i> (white var.) <i>Urginea indica</i>	{ Liliaceæ

#### B. Unofficial.

<i>Allium</i> (Garlic)	<i>Allium sativum</i>	Liliaceæ
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The entire bulb of Mediterranean Squill or *Urginea maritima* is tunicated, pear shaped, up to 30 cm. in diameter, up to about 6 pounds in weight and consists of a short, basal stem bearing rootlets below and fleshy scales laterally, the latter closely applied around each other in concentric fashion. These are invested on the exterior by brownish, dry, membranous outer scales.

The drug *Scilla* consists of pale yellow to yellowish-orange, entire or broken, transverse slices of fleshy inner bulb scales, which are frequently curved or arranged in concentric fashion. These have a weak fracture and mucilaginous, bitter taste. The diagnostic microscopical features are numerous mucilage sacs, long raphides of calcium oxalate and spiral ducts.

*Allium* occurs as entire, compound, fresh bulbs of a white or pink color with smooth stems. Each compound bulb consists of 8 to 15 ovoid bulbels surrounded by whitish membranous scales and showing numerous yellowish-white rootlets arising from a circular base. The odor is strongly and characteristically aromatic, and the taste is strongly pungent.

### CORM

A **corm** is an excessively thickened, solid and erect subterranean stem.

TITLE	BOTANICAL ORIGIN	FAMILY
Colchici Cormus (Colchicum-root) N.F.	<i>Colchicum autumnale</i>	Liliaceæ

*Colchicum* Corm consists of transverse, reniform, or longitudinal, somewhat ovate slices of the corm, the cut surfaces of which are grayish-white, dotted with resin and scattered bundles. They have a starchy, bitter and acrid taste.

The entire corm is sub-conical and covered with two membranous scale leaves. Upon removal of the scale leaves, a groove will be noted which is occupied by a portion of the flower bud (in summer) or, flower stalk in autumn. At the base will be noted the rootlets and laterally, a scar indicating the place of attachment of the previous year's corm.



## BARKS

**Bark** is all that portion of a woody exogenous plant axis found outside of the cambium.

## A. Those official in the U.S.P. XIII.

TITLE	BOTANICAL ORIGIN	FAMILY
Cascara Sagrada	Rhamnus Purshiana	Rhamnaceæ
Cinnamomum (Saigon Cinnamon)	Cinnamomum Loureirii	Lauraceæ
Prunus Virginiana (Wild Black Cherry Bark)	Prunus serotina	Rosaceæ

## B. Those official in the N.F. VIII.

Cinchona (Peruvian Bark)	{ Cinchona Ledgeriana, C. Calisaya, } { Cinchona succirubra and hybrids }	{ Rubiaceæ }
Cinnamomum Zeylanicum (Ceylon Cinnamon)	Cinnamomum zeylanicum	Lauraceæ
Gossypii Radicis Cortex (Cotton Root Bark)	{ Cultiv. vars. of Gossypium hirsu- } { tum or other Gossypium spp. }	{ Malvaceæ }
Mezereum	{ Daphne Mezereum { Daphne Gnidium { Daphne Laureola }	{ Thymeleaceæ }
Pinus Alba (White Pine)	Pinus strobus	Pinaceæ
Quillaja (Soapbark)	Quillaja Saponaria	Rosaceæ
Sassafras	{ Sassafras albidum	Lauraceæ
Ulmus (Elm)	{ Ulmus fulva	Ulmaceæ
Viburnum Opulus (True Cramp Bark)	{ Viburnum Opulus var. americanum } { (V. trilobum) }	{ Caprifoliaceæ }
Viburnum Prunifolium (Black Haw)	{ Viburnum Prunifolium { Viburnum rufidulum }	{ Caprifoliaceæ }

## C. Other medicinal barks.

Alstonia (Dita Bark)	{ Alstonia constricta { Alstonia scholaris }	{ Apocynaceæ }
Canella (Winter's Bark)	Canella Winterana	Canellaceæ
Chionanthus (Fringe Tree Bark)	Chionanthus virginicus	Oleaceæ
Cocillana (Huapi Bark)	Guarea Rusbyi	Meliaceæ
Condurango (Condor-vine Bark)	Marsdenia Cundurango	Asclepiadaceæ
Cornus (Dogwood)	Cornus florida	Cornaceæ
Euonymus (Wahoo)	Euonymus atropurpureus	Celastraceæ
Frangula (Buckthorn Bark)	Rhamnus Frangula	Rhamnaceæ
Granatum (Pomegranate)	Punica Granatum	Punicaceæ
Juglans (Butternut Bark)	Juglans cinera	Juglandaceæ
Myrica (Bayberry Bark)	{ Myrica cerifera and M. pensylvan- } { ica }	{ Myricaceæ }
Piscidia (Jamaica Dogwood)	Piscidia piscipula	Leguminosæ
Quercus (White Oak Bark)	Quercus alba	Fagaceæ
Rubus (Blackberry Bark)	{ The Section Eubatus of the genus } { Rubus }	{ Rosaceæ }

TITLE	BOTANICAL ORIGIN	FAMILY
Yohimbe	Corynanthe johimbe	Rubiaceæ
Xanthoxylum	{ Zanthoxylum americanum	{ Rutaceæ
(Prickly Ash Bark)	{ Zanthoxylum Clava-Herculis	

**Barks** are considered as to their physical characteristics, histology and microscopical features of their elements, as examined in the form of a powder.

The study of their physical characteristics should include occurrence, size, nature of outer surface, inner surface, fracture, internal appearance, odor and taste.

Most of the drug barks have periderm present. Exceptions to this rule are Cinnamomum Zeylanicum, Sassafras, Ulmus, Canella, Fraxinus, Juglans, Pinus Alba, Quercus, rossed Prunus Virginiana, rossed Viburnum Prunifolium, and Quillaja.

When the term bark without limitation is employed in pharmacognic and materia medica texts, the stem bark is usually to be inferred. Both the stem and root barks of Cinchona and Viburnum Prunifolium are recognized by the N.F.

Several of the barks are directed by the standards to be obtained only from the root. These are Sassafras, Euonymus, Chionanthus and Gossypii Radicis Cortex. Rubus consists of the bark of the rhizome and root. Myrica of commerce sometimes consists of the bark of the aerial stem, rhizome and root, although most of it represents root bark. Granatum (Pomegranate Bark) consists of bark of stem and root.

**Macroscopic Examination.**—In the macroscopic examination of barks, the presence of lichens and mosses on the outer surface is to be noted since these are of some aid in distinguishing stem barks from root barks. For certain barks, the lenticels by their prominence, shape and abundance, are characteristic and of aid in distinguishing the species.

During the drying process barks shrink and tend to develop certain characteristic degrees of curvature. When the curvature is slight the bark is called "*curved*"; when the curvature is such as to form a trough the bark is called "*channelled*." If the bark curls so that one edge overlaps the other forming a tube or cylinder, it is called a "*quill*" or "*single quill*," and if the bark curls from both edges and by each edge rolling inward forms a double curl or two cylinders, it is called a "*double quill*." Barks consisting of inner bark only tend to remain flat as loss of moisture in drying is more or less even from both surfaces.

Barks occur either in the form of single quills as Cinnamomum Saigonum and the Cinchonas, in congeries of quills as Cinnamomum Zeylanicum, where several quills are inside of each other, or in transversely curved pieces as Condurango and Xanthoxylum, or in flat pieces as Cornus, or in flat, slab-like pieces as in Quillaja and Ulmus, or as a mixture of partially quilled and quilled pieces as Gossypii Radicis Cortex and Rubus.

In the examination of the outer surface of a bark, it is important to note the presence or absence and character of prickles, lenticels, mosses, lichens and their apothecia, fissures, as well as its color.

The examination of the inner surface should embody color, striations, fur-

rows, and the tendency of the inner fibers to separate, as in *Gossypii Radicis Cortex*, *Mezereum*, *Condurango*, *Quercus* and *Ulmus*.

Examination of a smoothed transverse surface, stained with Phloroglucin-HCl, under a hand lens is often helpful in diagnosis, since it will reveal the arrangement of the lignified tissues and medullary rays.

The fracture may be short and very weak as in *Viburnum Opulus*, *Cinnamomum Zeylanicum* and *Cascarilla*, short and brittle as in *Cascara Amarga*, *Prunus Virginiana*, *Sassafras*, *Cascara*, etc., tough fibrous as in *Cinchona*, *Chionanthus*, *Condurango*, etc., or very tough fibrous as in the unofficial *Aspidosperma* and *Paracoto*. The examination of fractured surface should include color and the presence or absence of projecting fibers or stone cells.

**Histology.**—The microscopical study of barks should embrace their study in transverse, longitudinal-radial and longitudinal-tangential sections as well as their appearance in powdered form. In some instances it is advisable to digest small pieces or shavings of the bark in Schulze's maceration fluid, wash in water and tease apart the lignified elements, in order to best observe them in their entire condition. Scrapings of the bark surfaces have been found very helpful in studying the characteristics of their histological elements.

**Stem barks** in their entire condition show the following tissue regions, passing from outer to inner surface:

1. Cork (periderm).
2. Cork cambium (phellogen).
3. Cortex { a. secondary—usually (phelloderm).  
b. primary—constant.
4. Pericycle.
5. Phloem, traversed by phloem rays.

**Root barks** in their entire condition exhibit the following regions of tissues, passing from outer to inner surface:

1. Cork (periderm).
2. Cork cambium (phellogen).
3. Secondary cortex.
4. Phloem, traversed by phloem rays.

Whenever no sclerenchyma elements occur in the pericycle, for all practical purposes the pericycle is usually included with the cortex and the two regions collectively termed "cortex."

The three most important regions in the average bark upon which detailed histological studies should be made are (1) outer bark or cork, (2) middle bark or cortex and (3) inner bark or phloem.

The cork tissue varies in different barks as to the size and nature of its cells as well as to their arrangement. The cell walls in particular should be observed to determine first whether any lignification is present or whether they are entirely suberized and second, whether they differ as to thickening. The character of the cell contents should likewise be noted.

In most barks, cork is found only on the outer face as a product of the

secondary meristem known as cork cambium, but in others, as *Quercus*, zones of cork may occur at varying levels in the cortex, pericycle and phloem, due to the appearance in these regions of tertiary meristems.

**Powdered Barks.**—The identification of a powdered drug, as that of a bark, may be made upon observations showing a considerable number of large sieve tubes whose callus plates stain pink in corallin-soda solution, the occurrence of cork tissue (absent in some barks because of preparation), the absence of mesophyll tissue, aleurone grains and of tracheæ in abundance. Many commercial barks have pieces with adhering wood which accounts for the presence of a few tracheæ in some mounts of powdered barks.

### WOODS

#### A. Official in the U.S.P. XIII.

TITLE	BOTANICAL ORIGIN	FAMILY
Santalum Rubrum (Red Saunders)	Pterocarpus santalinus	Leguminosæ

#### B. Those official in the N.F. VIII.

Quassia	{ <i>Picrasma excelsa</i> <i>Quassia amara</i>	} Simarubaceæ
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#### C. Other medicinal and dye woods.

Brazil Wood	<i>Cæsalpinia brasiliensis</i>	Leguminosæ
Guaiaci Lignum	{ <i>Guajacum officinale</i> <i>Guajacum sanctum</i>	{ Zygophyllaceæ
Haematoxylon (Logwood)	<i>Haematoxylon campechianum</i>	Leguminosæ
Sappan	<i>Cæsalpinia Sappan</i>	Leguminosæ
Santalum Album (White Sandalwood)	<i>Santalum album</i>	Santalaceæ
Carbo Ligni (Wood Charcoal)	<i>Salix</i> , <i>Populus</i> , etc.	Salicaceæ, etc.

### PITH

TITLE	BOTANICAL ORIGIN	FAMILY
Sassafras Medulla	<i>Sassafras albidum</i>	Lauraceæ

The wood drugs include those portions of woody exogenous plant axes lying inside of the cambium line. Those official represent the wood of Dicotyl stems. The outer whitish layers of wood which contain living cells, functioning in the vegetative processes of the plant, make up what is termed *sapwood* or *alburnum*. *Quassia* is the only official example of a sapwood. The inner dead layers of wood which have been more or less infiltrated with extractive and coloring matter and which have ceased to function as sap-transporting elements constitute what is called *heartwood* or *duramen*. The official representative of this class is *Santalum Rubrum*.

*Carbo Ligni* represents a black powder obtained from soft wood. It has been replaced in the U.S.P. by *Carbo Activatus* which represents the residue from the destructive distillation of various organic materials, treated to increase its adsorptive power.

In the macroscopic examination of woods cognizance is taken of their manner of occurrence, color, markings, fracture, odor and taste.

In the microscopic examination of woods, the following points should be considered:

1. The distribution and arrangement of the tissues particularly the tracheæ, wood parenchyma and xylem rays.
2. The range in width of the medullary rays as observed in tangential sections.
3. The character of the tracheæ, tracheids and wood fibers in respect to relative width, thickness of walls, markings on walls, etc.
4. The presence or absence of starch and crystals. If these be present, their shape and size should be ascertained.
5. The presence or absence of secretion sacs or reservoirs and the nature of their contents.
6. The presence of an abnormal structure or absence of one known to occur in the authentic article.

#### LEAVES

##### A. Those official in the U.S.P. XIII.

TITLE	BOTANICAL ORIGIN	FAMILY
Digitalis (Foxglove)	Digitalis purpurea	Scrophulariaceæ
Hyoscyamus (Henbane)	Hyoscyamus niger	Solanaceæ

##### B. Those official in the N.F. VIII.

Buchu	{ Barosma betulina, B. crenulata, and B. serratifolia	{ Rutaceæ
Eriodictyon (Yerba Santa)	Eriodictyon californicum	Hydrophyllaceæ
Hamamelidis Folium (Witch-hazel Leaves)	Hamamelis virginiana	Hamamelidaceæ
Salvia (Sage)	Salvia officinalis	Labiataæ
Uva Ursi (Bearberry)	{ Arctostaphylos Uva-ursi and vars. coactylis and adenotricha	{ Ericaceæ

##### C. Other medicinal leaves.

Althææ Folia	Althæa officinalis	Malvaceæ
Boldus	Peumus Boldus	Monimiaceæ
Castanea (Chestnut)	Castanea dentata	Fagaceæ
Chimaphila (Pipsissewa)	Chimaphila umbellata	Ericaceæ
Coca	{ Erythroxylon Coca, E. truxil- lense, and E. novogranatense	{ Erythroxylaceæ
Damiana	{ Turnera diffusa Turnera aphrodisiaca	{ Turneraceæ
Eucalyptus	Eucalyptus globulus	Myrtaceæ
Farfara (Coltsfoot Leaves)	Tussilago Farfara	Compositæ
Laurus (Bay Leaf)	Laurus nobilis	Lauraceæ
Lawsonia (Henna)	Lawsonia inermis	Lythraceæ
Malvæ Folia	{ Malva neglecta Malva sylvestris	{ Malvaceæ
Matico (Soldier's Shrub)	Piper angustifolium	Piperaceæ
Verbasci Folia (Mullein Leaves)	Verbascum Thapsus	Scrophulariaceæ

## LEAFLETS

## A. Official in U.S.P. XIII.

TITLE	BOTANICAL ORIGIN	FAMILY
Senna	{ <i>Cassia acutifolia</i> <i>Cassia angustifolia</i>	{ Leguminosæ

## B. Unofficial.

Pilocarpus ( <i>Jaborandi</i> )	{ <i>Pilocarpus Jaborandi</i> <i>Pilocarpus microphyllus</i>	{ Rutaceæ
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## LEAF BUDS

## Official in N.F. VIII.

TITLE	BOTANICAL ORIGIN	FAMILY
Populi Gemma ( <i>Poplar Bud</i> )	{ <i>Populus Tacamahacca</i> (P. bal- samiifera) <i>Populus candicans</i>	{ Salicaceæ

**Leaves** are generally flattened, rarely semi-centric, or centric-lateral expansions developed by the stem or by branches and in whose axils one or more branches arise.

In the study of the physical characteristics of leaves and leaflets it is important to note the general outline, apex, base, margin, nature of petiole if present, length and breadth of lamina, surfaces, texture, color of both surfaces and venation, odor and taste. Very frequently, as in *Hamamelidis Folium*, *Digitalis*, *Stramonium*, *Castanea* and *Matico*, the leaves are more or less crumpled and broken. Such specimens should be spread out, after first macerating in water, in order to properly study the nature of the margin.

**Histology.**—The microscopic examination should include the study of surface sections of both upper and lower epidermis as well as transverse sections. In this connection it is well to state that dried leaves are best prepared for sectioning by exposure to the atmosphere of a moist chamber for 24 hours or longer until sufficiently supple. Transverse sections can then be had by imbedding between the halves of elder pith preparatory to cutting. Surface sections may be prepared for cutting by bending the leaf over the index finger and holding it firmly between the index finger and the third finger on the one end and with the thumb on the other. Another method of preparing surface sections is as follows: Place a representative portion of the leaf not over  $\frac{1}{4}$  inch square in a watch crystal with chloral hydrate solution, warm gently for several minutes, according to the texture of the leaf, transfer to clean slide, add a drop or two of chloral solution, cover with cover slip and exert pressure on the slip with a rotary movement, describing the figure 8. The epidermis will thereby readily be separated from the leaf parenchyma and fibrovascular tissue.

In case good sized portions of leathery leaves are available and the task is that of studying large areas of epidermis, these may be prepared by boiling the leaf material in 10 to 20 per cent. solutions of sodium or potassium hydroxide until the epidermis puckers up in the form of blisters, when they should be

removed to a slide and the epidermis lifted off by means of fine forceps or dissecting needles.

It is frequently necessary to clear leaf material before examination. This may be accomplished by allowing it to macerate in saturated solution of chloral hydrate for a day or longer or by the use of Labarraque's solution or Javelle Water in case hasty examination is urgent. The main disadvantages in the use of Labarraque's and Javelle Water are first—the appearance of numerous bubbles in material which frequently obscure the field and second—the danger of over bleaching, when conducted by an inexperienced individual. In all cases the material should be washed in water before examination.

The microscopic structures to be observed in leaves are as follows:

1. *Upper and lower epidermis*—thickness and color of cuticle; outline of epidermal cells as seen in transverse and vertical view; nature of vertical walls, whether rectilinear (straight) or curvilinear (wavy); presence or absence of stomata with accompanying guard cells or of water stomata; the number and arrangement of the neighboring-cells, if present; presence or absence of hairs and their character, whether non-glandular or glandular; if non-glandular, whether simple, aggregate, or branched, unicellular or multicellular, uniseriate or multiseriate, non-papillated or papillated, whether certain cells are collapsed in the course of the hair as in *Digitalis*, and whether the hair is inserted between epidermal cells or occurs as an outgrowth of them; if glandular, whether stalked or sessile, whether stalk, if present, is uniseriate or multiseriate and the number of cells in length or rows of cells (in the case of multiseriate hairs) comprising the stalk, the number of cells comprising the head and the shape of the head. In certain instances it is necessary to measure the length of the hairs and their breadth at the base. The nature of the distal cell of the non-glandular hair is also to be observed.

2. *Mesophyll*—including arrangement of the palisade and spongy parenchyma regions, presence or absence of crystals, their nature, size and position, presence or absence of stone cells or idioblasts, size of cells and intercellular-air-spaces, presence or absence of secretion sacs or internal glands and the character of their contents, nature of fibrovascular elements.

3. *Midrib and Petiole*—outline in cross section, arrangement and character of bundles, nature of endodermis, presence or absence of sclerenchyma elements in the pericycle adjacent to the bundles, presence or absence of crystals, their nature and size, presence or absence of collenchyma and its position.

**Powdered Leaves.**—The diagnosis of an unknown sample as that of a powdered leaf should be based upon the microscopic observation of the presence of a preponderance of mesophyll elements, of some epidermal tissue showing stomatal apparatuses and usually hairs, fragments of veins and the absence of cork (with few exceptions as *Eucalyptus*, *Stramonium*, etc.), aleurone grains and a large amount of woody tissues including large vessels. Most leaf powders are green in color. In some instances the color merges into brown or yellowish brown, as in *pilocarpus*, *henna*, *coca*, and old leaf powders.

## STEMS

**Stems** are those parts of plant axes which bear leaves or leaf modifications.

TITLE	BOTANICAL ORIGIN	FAMILY
Cactus Grandiflorus	Selenicereus grandiflorus	Cactaceæ
Dulcamara (Bittersweet)	Solanum Dulcamara	Solanaceæ
Ephedra (Ma Huang)	Ephedra distachya	Gnetaceæ
	Ephedra equisetina	
	Ephedra sinica	
	Ephedra Gerardiana	
Scoparius (Broom Tops)	Cytisus scoparius	Leguminosæ
Thuja (Leafy twigs) (Arbor Vitæ)	Thuja occidentalis	Pinaceæ

The medicinal aerial stems listed above are all derived from Dicotyledons and Gymnosperms and therefore exhibit exogenous stem structure. In the study of the physical characteristics of stems, attention should be paid to the following points: occurrence, range in diameter, outline, whether simple or branched, surface, color, fracture, internal appearance, odor, and taste.

Cactus occurs as fresh stems, and Dulcamara as dried stems. The former is cut into long segments, the latter into very short segments with a hollow center. Scoparius occurs in cut and broken branches; Thuja in broken branches; Ephedra as entire cut or broken green branches. The range in diameter of Cactus is from 1.5 cm. to 4 cm.: of Dulcamara, 4 mm. to 7 mm., of Scoparius, 1 mm. to 3 mm., Thuja, from 2 mm. to 4 mm., and Ephedra, up to 2 mm. The outline of Cactus is wavy and angular; of Dulcamara cylindrical; of Scoparius five angled; of Thuja irregular, and of Ephedra terete or flattened at base. Scoparius and Thuja alone show branching. Cactus has a succulent texture, the others are fibrous. The surface of Cactus is deeply longitudinally channeled and marked by tufts of spines, and at irregular intervals shows nodes, some with branched rootlets; of Dulcamara striated; of Scoparius five angled; of Thuja, covered with four rows of appressed leaves; of Ephedra longitudinally-striate and marked by nodes bearing opposite membranous to coriaceous sheathing leaves, the internodes of varying length. The color of Cactus is dark green; of Dulcamara greenish-brown; of Scoparius greenish-brown to greenish-black; of Thuja dark green to reddish-brown; of Ephedra grayish green.

The fracture of Scoparius is tough and uneven; of Dulcamara, brittle and uneven; of Thuja, fibrous; of Ephedra, brittle.

Internally, Cactus shows a broad mucilaginous cortex and a small fibrous pith; Dulcamara shows a thin greenish-brown cortex, a narrow brownish wood and usually a hollow pith; Scoparius has a thin cortex, broad yellow wood and narrow pith; Thuja a thin cortex and fibrous wood; Ephedra a narrow cortex separated from a broad pith by a circle or ellipse of small bundles.

The odor of Cactus is slightly aromatic; of Dulcamara and Scoparius indistinct; of Thuja characteristically aromatic; of Ephedra, aromatic upon crushing.

The taste of Cactus is acidulous and mucilaginous; of Dulcamara bitter, then sweet; of Scoparius bitter; of Thuja terebinthinate and bitter; of Ephedra aromatic, bitter and astringent.



**Histology.**—The histological study of the stem drug should include an inquiry into its appearance in transverse, radial-longitudinal, and tangential-longitudinal sections, as well as the examination of its cellular elements, when isolated. While transverse sections through the internodal portions of the official stems are frequently diagnostic for the whole stem drugs, it is, nevertheless, important to study longitudinal sections in order to learn the lengthwise appearance of the cellular elements, which usually are so cut in the grinding of drugs. The range in width and the depth of the medullary rays can be best ascertained through the examination of the stem in tangential-longitudinal sections and types of crystals as well as the lengthwise characteristics of the cellular elements from radial-longitudinal sections. The latter type of section is most helpful in preparation for the study of the powdered drug.

Every dicotyl or gymnosperm stem exhibits internally a central pith which is immediately surrounded by a circular zone of wood; outside of the wood is a delicate growing layer of cambium which separates the internal wood from the external ring of bark. If the aerial stem be that of less than one year's growth, the following regions will be observed, passing in order from outer surface to center: Epidermis, primary cortex, endodermis, pericycle, primary phloem, cambium, primary xylem, and pith. If it be of more than one year's growth, as in the aerial stems of perennials below the distal node, the following regions will be observed: (1) Epidermis, in the process of peeling off, or entirely absent; (2) Cork; (3) Cork cambium (generally shrunken in dried stems); (4) Secondary cortex; (5) Primary cortex; (6) Endodermis; (7) Pericycle; (8) Primary phloem; (9) Secondary phloem; (10) Cambium (usually with cells more or less collapsed in dried stems); (11) Secondary xylem; (12) Primary xylem; (13) Pith.

The phloem, cambium, and xylem regions are separated into a number of wedges by means of strands of parenchymatous cells, known as medullary rays, that course like the spokes of a wheel through these regions. The primary medullary rays (coursing from pith to cortex) separate the fibro-vascular bundles one from the other. It is this type of medullary ray which, if followed outward to its termination, marks the outer limit of the phloem, and so is helpful in the study of transverse sections of stems whose phloem shows few or no bast fibers in determining the boundary line between phloem and pericycle.

The epidermis consists of a single row of epidermal cells, that are usually tangentially elongated in transverse sections, and axially elongated in the longitudinal sections. In drug stems, it is always covered with a cuticle and usually shows stomata. Hairs (trichomes) are sometimes found which are outgrowths of epidermal cells. They may be non-glandular or glandular in character.

The cortex is commonly composed of cortical parenchyma tissue, the cells of which are frequently collenchymatic in the outer part abutting the epidermis. (Their walls are thickened with a colloidal substance, particularly at the angles.) Moreover, outer rows of cells are generally tangentially elongated, and usually

contain chloroplasts. In passing toward the inner margin of the cortex, the cells generally become rounded off and isodiametric. In the examination of this region, it is important to note any variation from the structure outlined, for such aids in the diagnosis of the drug.

The following kinds of cellular elements are to be looked for: stone cells; sclerenchyma fibers; secretion sacs; internal glands; laticiferous cells or vessels; and internal hairs.

The character of the cell contents should also be noted. Among those apt to occur are the following: starch; calcium oxalate crystals; cystoliths; resin; tannin; oil; sugars; alkaloids; glucosides; etc.

The endodermis, or innermost layer of cells of the cortex, is generally indistinguishable from the other layers of the cortex, but in some stems, especially in their early growth, can be recognized by the following characteristics: 1. The rectangular form of the cells in cross section; and the absence of intercellular air spaces; 2, the presence of abundant starch, and 3, the appearance of suberized or lignified walls, especially the radial walls of the cells of this layer.

The pericycle, in many stems, is also indistinguishable from the cortex but in many others, especially stems of climbing plants, can be made out by the presence of sclerenchyma fibers or stone cells or both, which may either be isolated, occur in small groups, or form a continuous or discontinuous ring. This region may consist of one or more rows of parenchymatous cells.

The phloem, which follows the pericycle, tends to be narrow in herbaceous stems, broader in stems of shrubs and trees. It always contains sieve tubes and phloem parenchyma, and phloem (medullary) rays. In addition, bast fibers and stone cells as well as laticiferous tissue, oil glands, and calcium oxalate cells are apt to be found, either of which is helpful in diagnosis, and should be noted. The absence of bast fibers, etc., in the phloem is also frequently diagnostic.

The xylem or wood region, found directly within the cambium, shows variation in structure depending upon the group of plants in which it occurs. In stems of conifers it is composed wholly or chiefly of tracheids with a single row of bordered pores and xylem medullary rays. In stems of Dicotyledons, it varies often with tracheids with bordered pores and xylem medullary rays, but the pitted tracheids are marked on their longitudinal walls by more than one layer of bordered pores. Moreover, in addition to these elements, wood parenchyma is almost always present, and tracheæ and wood fibers are very common.

In the stems of some dicotyledons isolated patches of sieve tissue will be found scattered here and there in the xylem region. This is called "*interxylary phloem*" or "*internal phloem*" and has been observed in the following families: *Loganiaceæ*, *Gentianaceæ*, *Convolvulaceæ*, *Cucurbitaceæ*, *Combretaceæ*, *Myrtaceæ*, *Punicaceæ*, *Apocynaceæ*, *Asclepiadaceæ*, *Acanthaceæ*, *Euphorbiaceæ*, *Melastomaceæ*, etc. *Intraxylary phloem* in the form of sieve tissue with or without accompanying bast fibers may be found on the inner face of the xylem and, when present, should be noted. It has been observed in the stems of members of the following drug yielding families: *Loganiaceæ*, *Gentianaceæ*, *Papilionaceæ*, *Oleaceæ*,

*Combretaceæ, Solanaceæ, Cucurbitaceæ, Convolvulaceæ, Melastomaceæ, Apocynaceæ, Asclepiadaceæ, Thymeleaceæ, Acanthaceæ, Euphorbiaceæ, Malphigiaceæ, and Polygonaceæ.*

Such microscopic features as enumerated under the captions of Wood and Xylem of roots should be noted in addition to those here presented.

The pith consists of parenchyma cells which are frequently pitted. In some instances, during the development of this region, modifications of the walls and contents of the cells occur. The presence of lignified walls, stone cells, sclerenchyma fibers, laticiferous elements, crystals of calcium oxalate, cystoliths, secretion sacs, internal glands, hairs, starch grains, mucilage sacs, tannin cells, etc., should always be noted.

Fibrovascular bundles occur in the pith region of certain stems belonging to the *Polygonaceæ, Piperaceæ*, etc., and when present are valuable aids in diagnosis. The stems of several genera, including *Phytolacca, Ipomoea, Exogonium, Amaranthus, Cucurbita*, etc., show more than one circle of bundles outside the pith region.

**Powdered Stems.**—Powdered stems are characterized by an abundance of woody tissues including wood fibers, medullary rays, tracheae and tracheids, the presence of cork or epidermal tissue, ordinary parenchyma, chlorenchyma and frequently of collenchyma. Stone cells, hairs and laticiferous tissue may or may not be present. If present, either of these elements are frequently diagnostic.

#### LEAVES AND FLOWERING OR FRUITING TOPS

##### A. Those official in the U.S.P. XIII.

TITLE	BOTANICAL ORIGIN	FAMILY
Belladonnæ Folium (Deadly Nightshade)	Atropa Belladonna	Solanaceæ
Hyoscyamus (Henbane)	Hyoscyamus niger	Solanaceæ
Mentha Piperita (Peppermint)	Mentha piperita	Labiatae
Mentha Viridis (Spear-mint)	Mentha spicata	Labiatae
Stramonium (Jimson Weed)	Datura Stramonium (including <i>D. Tatula</i> )	Solanaceæ

##### B. Those official in the N.F. VIII.

Cataria (Catnip)	Nepeta Cataria	Labiatae
Eupatorium (Boneset)	Eupatorium perfoliatum	Compositæ
Grindelia (Grindelia Robusta)	Grindelia camporum Grindelia humilis Grindelia squarrosa	Compositæ
Lobelia (Asthma Weed)	Lobelia inflata	Lobeliaceæ
Thymus (Thyme)	Thymus vulgaris	Labiatae

##### C. Other medicinal leaves and flowering tops.

Cannabis (Indian Hemp)	Cannabis sativa	Moraceæ
Thymus Serpyllum (Wild Thyme)	Thymus Serpyllum	Labiatae

**ENTIRE PLANT DRUGS ("HERBS")**

TITLE	BOTANICAL ORIGIN	FAMILY
Centaurium (Bitter Herb)	Centaurium umbellatum	Gentianaceæ
Chirata (Bitter Stick)	Swertia Chirayita	Gentianaceæ
Chondrus, N.F. (Irish Moss)	{ Chondrus crispus Gigartina mamilliosa	{ Gigartinaceæ
Coptis (Goldthread)	Coptis groenlandica	Ranunculaceæ
Drosera (Sundew)	{ Drosera rotundifolia Drosera anglica Drosera longifolia	{ Droseraceæ
Euphorbia Pilulifera	Euphorbia pilulifera	Euphorbiaceæ
Fucus (dried thallus) (Bladderwrack)	Fucus vesiculosus et. al. spp.	Fucaceæ
Mitchella (Partridge Berry)	Mitchella repens	Rubiaceæ
Senecio (Life Root)	Senecio aureus	Compositæ

**OVERGROUND PORTIONS OF PLANTS ("HERBS")**

TITLE	BOTANICAL ORIGIN	FAMILY
Adonis (Pheasant's Eye)	Adonis vernalis	Ranunculaceæ
Galega (Goat's Rue)	Galega officinalis	Leguminosæ
Passiflora (Passion Flower)	Passiflora incarnata	Passifloraceæ
Pulsatilla (Pasqueflower)	{ Anemone Pulsatilla Anemone pratensis Anemone patens	{ Ranunculaceæ
Scutellaria (Scullycap)	Scutellaria lateriflora	Labiataæ

**FLOWERS AND FLORAL PARTS**

**Flowers** are shoots which have undergone modifications so as to serve as a means for the propagation of the individual.

TITLE	BOTANICAL ORIGIN	FAMILY
1. Unexpanded Bud		
Caryophyllus (Clove), U.S.	Eugenia caryophyllata	Myrtaceæ
2. Petals		
Rosa (Rose) N.F.	Rosa gallica	Rosaceæ
3. Flowers		
Sambucus (Elder Flowers)	{ Sambucus canadensis Sambucus nigra	{ Caprifoliaceæ
4. Corollas (with adhering stamens)		
Verbasci Flores (Mullein Flowers)	{ Verbascum phlomoides Verbascum thapsiforme	{ Scrophulariaceæ
5. Stigmas		
Crocus (Saffron)	Crocus sativus	Iridaceæ
6. Fresh Styles and Stigmas		
Zea (Corn-silk), N.F.	Zea Mays	Gramineæ
7. Ligulate Floret		
Calendula (Marigold), N.F.	Calendula officinalis	Compositæ
8. Inflorescences		
Brayera (panicle)	Hagenia abyssinica	Rosaceæ
Flores Tiliae (cyme) (Linden Flowers)	{ Tilia europæa Tilia platyphyllos	{ Tiliaceæ

TITLE	BOTANICAL ORIGIN	FAMILY
9. Flower Heads		
Anthemis (Roman Chamomile)	Anthemis nobilis	Compositæ
Arnica, N.F.	{ Arnica montana Arnica fulgens Arnica sororia Arnica cordifolia	{ Compositæ
Matricaria (German Chamomile), N.F.	Matricaria Chamomilla	Compositæ
Pyrethrum (Insect Flowers), N.F.	{ Chrysanthemum cinerariaefolium Chrysanthemum coccineum Chrysanthemum Marschallii	{ Compositæ
Trifolium (Red Clover Blossoms)	Trifolium pratense	Leguminosæ
10. Unexpanded Flower Head		
Santonica (Levant Wormseed)	Artemisia Cina	Compositæ

The official flower drugs have all been derived from Angiosperms. A typical angiospermous flower consists of four whorls of floral leaves arranged upon the swollen summit of the flower stalk known as the *Receptacle*. These, from without inward, are the *Calyx*, *Corolla*, *Andræcium* and *Gynæcium*. The arrangement of the flowers upon the stem is termed *Inflorescence* or *Anthotaxy*. The flowers may occur singly on the stem or in clusters. In a flower cluster, the stalk bearing the cluster is termed the *Peduncle*; the continuation of the peduncle as an axis along which the flowers are arranged, the *Rachis*. The stalks which arise either from the summit of the peduncle or the rachis are termed *Pedicels*. Peduncles, pedicels and receptacles are modified stem structures. The modified leaves occurring along the peduncle or rachis are known as *Bracts*, while those occurring on the pedicels are known as the *Bracteoles*. The *Involucre* represents one or more whorls of bracts.

The types of inflorescences represented among the flower drugs are the *Raceme*, *Panicle*, *Cyme* and *Capitulum* (Flower head). The raceme, illustrated by *Convallariæ Flores* (unofficial) consists of a peduncle with its elongated rachis, the latter bearing alternate bracts in the axils of which pedicels arise, each of which terminates in a single flower. The flowers open in order from the base toward the summit.

The *Panicle*, illustrated by the drug *Brayera*, is a compound raceme, which differs from a raceme in showing branched pedicels, the secondary pedicels terminated by flowers.

The simple cyme, illustrated by *Flores Tiliæ* or Linden Flowers, consists of a main axis composed of peduncle and its elongation, the rachis, which ends in a flower and two branches arising from buds in the axils of bracteoles at the junction of rachis and peduncle both ending in a flower, the central flower opening first. In Linden, the cyme arises from the midrib of a tongue-shaped bract.

The *Capitulum*, or flower head, is the common type of inflorescence for all

the *Compositæ*, as well as for some of the *Campanulaceæ* and the *Leguminosæ*. It consists of a number of small flowers called *Florets* inserted on a compound receptacle that terminates the flower stalk. The common receptacle is usually surrounded on its exterior by one or more circles of bracts, often arranged in imbricate fashion. The florets which are imbedded in the receptacle may be all tubular, as in the flower heads of *Santonica*, *Eupatorium*, and *Absinthium*, or they may be all ligulate, as in *Dandelion*, *Chicory*, the *Hawkweeds*, and cultivated *Anthemis nobilis*. Sometimes the florets may be partly tubular (disk florets) and partly ligulate (ray florets) as in *Matricaria*, wild *Anthemis*, *Pyrethri Flores*, *Arnica*, or they may be all papilionaceous as in *Trifolium*.

In the study of flowers, the physical characteristics of the peduncle and the various whorls should be first considered. In this work, a hand lens or dissecting microscope, needles and penknife will be found advantageous during dissection. The presence or absence of nectaries and their position should be ascertained. Following this, examination with the aid of the compound microscope can be made of the various parts, and finally, the powdered drug can be examined.

In the examination of the receptacle, the shape should be noted and, in the case of compound receptacles of the *Compositæ*, the upper surface should be examined with a hand lens for chaff which is often diagnostic. The receptacle should then be sectioned to ascertain whether it is hollow, as in *Matricaria*, or solid, as in *Anthemis*, and the sections examined for the presence of stone cells which are frequently diagnostic. The character of the bracts which may be attached to the outer surface should also be ascertained.

In the examination of the calyx and bracts, the methods employed in leaf examination obtain. Often, diagnostic structures may be found in the nature of epidermal cells with striated cuticle, hairs, stomatal apparatus, internal glands and crystals.

In the examination of the corolla, which is usually thinner and more delicate in structure than the calyx, mounts of petals should be made, and the characteristics of the epidermis ascertained, particularly as to the presence or absence of papillæ and cell contents. The mesophyll may then be examined for crystals, secretion sacs, and other diagnostic features.

In the examination of the stamens, attention should be particularly focused upon the pollen grains and the endothecium of the anther. Pollen grains are very frequently diagnostic for families, genera, and even species of plants. The shape and character of the outer wall or *exine* of these should always be observed. The character of the thickenings of the *endothecium* of the anther, which may be annular, spiral, or reticulate, may be determined.

In the study of the pistil, attention should be directed toward ascertaining the number of chambers in the ovary, the presence or absence of epidermal hairs and secretory tissue, size and character of papillæ, shape of the stigma, and the characteristics of the stigmatic papillæ. The papillose stigmatic tissue is diagnostic for flowers and often serves as an important differentiating structure in distinguishing powders of allied floral drugs.

It frequently happens that floral parts are densely colored, as in numerous petals, anthers, and stigmas. These can be decolorized, preparatory to microscopic examination, by maceration in water, or in very dilute ammonia water.

### POLLEN

**Pollen grains** or microspores are cells developed within the anther-sacs of flowers and which carry the male fertilizing element. Dehiscence of the anther reveals the pollen as a fine powder usually yellowish in color but sometime brown, pink, white or blue.

In its initial form, before it is conveyed by air currents, insects or water to the stigma, the pollen grain consists of a dense mass of protoplasm containing a nucleus and stored food which is enveloped by two membranes, the outer or *exine* and inner or *intine*.

Apart from the importance of pollen grains of many plant families as allergenic agents which is discussed in the previous chapter, they are often valuable aids in the identification of powdered drugs, spices and condiments and in the determination of the sources of honey. They vary in shape, dimensional size, and in the surface character of their outer wall or *exine*. The latter may or may not exhibit pores, furrows, reticulations, bands, warts, spines or granulations. Thus, pollen grains of conifers and other gymnosperms, Crocus, etc. are devoid of pores and furrows. Those of many grasses possess but one pore, Colchicum, 2 pores, Atropa Belladonna, Datura Stramonium and Hyoscyamus niger, 3 pores. The pollen grains of all the Pines are winged, those of Stramonium have a coarsely granular *exine*, those of many mints exhibit furrows and reticulations as external markings.

In the preparation of pollen grains for microscopical examination they may be mounted in water, in lactophenol, 25 per cent chloral hydrate, or warmed glycerin jelly. Iodine-chloral solution is advantageous as a mountant for the detection of starch and osmic acid solution for fixed oil content. If staining is desired the pollen grains are placed on a slide and stained with crystal violet in anilin oil, the latter made by tinting anilin oil to only a pale purple with crystal violet. Gently warm slide until the pollen becomes well stained, cool, remove excess oil with filter paper, remove excess stain from mount by washing with xylol and absorbing with absorbent paper until all the oil and unabsorbed stain are removed, add balsam and apply cover slip.

### FRUITS

**Fruits** consist of matured pistils or ovarian portions thereof, or in some instances of matured flowers or flower clusters. See part II.

#### A. Those official in the U.S.P. XIII.

TITLE	BOTANICAL ORIGIN	FAMILY
1. Cremocarps Carum (Caraway)	Carum Carvi	Umbelliferae
2. Rinds of Fruits Aurantii Amari Cortex (Bitter Orange Peel)	Citrus Aurantium	Rutaceae

TITLE	BOTANICAL ORIGIN	FAMILY
Aurantii Dulcis Cortex (Sweet Orange Peel)	Citrus Aurantium var. sinensis	Rutaceæ
Limonis Cortex (Lemon Peel)	Citrus Limon	Rutaceæ
3. Polishings of Fruit		
Perpolitiones Oryzæ (Rice Polishings)	Oryza sativa	Gramineæ

## Those official in the N.F. VIII.

## 1. Berries

Capsicum (Cayenne Pepper)	{ Capsicum frutescens, Capsicum annuum var. con- oides Capsicum annuum var. long- um Honka var. of Japanese Cap- sicum × Old La. Sport Cap- sicum }	Solanaceæ
Colocynthis (pulp) (Bitter Apple)	Citrullus Colocynthis	Cucurbitaceæ

## 2. Drupes

Cubeba (Cubeb-berries)	Piper Cubeba	Piperaceæ
Serenoa (Saw Palmetto)	Serenoa repens	Palmæ

## 3. Cremocarps

Anisum (Aniseed)	Pimpinella Anisum	Umbelliferæ
Coriandrum (Coriander-seed)	Coriandrum sativum	Umbelliferæ
Fœniculum (Fennelseed)	Fœniculum vulgare	Umbelliferæ

## 4. Capsules

Vanilla	{ Vanilla planifolia Vanilla tahitensis }	Orchidaceæ
Xanthoxyli Fructus (Prickly Ash Berries) (follicles)	{ Zanthoxylum americanum Zanthoxylum Clava-Herculis }	Rutaceæ

## 5. Galbulus

Juniperus (Juniper Berries)	{ Juniperus communis and var. depressa }	Pinaceæ
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## 6. Juices of Fruits

Succus Cerasi (Cherry Juice)	Prunus cerasus	Rosaceæ
Succus Rubi Idæi (Raspberry Juice)	{ Rubus idæus Rubus strigosus }	Rosaceæ

## C. Other medicinal fruits.

Anethum (Dill) (cremocarp)	Anethum graveolens	Umbelliferæ
Angelicæ Fructus (cremocarp)	{ Angelica Archangelica et al. spp. of Angelica }	Umbelliferæ
Apii Fructus (Celery Fruit) (cremocarp)	Apium graveolens	Umbelliferæ
Avæna (Oat)	Avena sativa	Gramineæ
Cassia Fistula (loment)	Cassia Fistula	Leguminosæ
Chenopodium (American Wormseed) (utricle)	{ Chenopodium ambrosioides var. anthelminticum }	Chenopodiaceæ
Conium (cremocarp)	Conium maculatum	Umbelliferæ
Cumini Fructus (cremocarp)	Cuminum Cyminum	Umbelliferæ
Ficus (Fig) (syconium)	Ficus Carica	Moraceæ
Humulus (Hop) (strobile)	Humulus Lupulus	Moraceæ



TITLE	BOTANICAL ORIGIN	FAMILY
Illicium (Star-anise) (follicles)	Illicium verum	Magnoliaceæ
Maltum (caryopsis)	Hordeum vulgare	Gramineæ
Piper (Pepper) (drupe)	Piper nigrum	Piperaceæ
Pimenta (Allspice) (berry)	Pimenta officinalis	Myrtaceæ
Prunum (drupe)	Prunus domestica	Rosaceæ
Rhamnus Cathartica (Buckthorn Berries)	Rhamnus cathartica	Rhamnaceæ
Rhus Glabra (drupe)	Rhus glabra	Anacardiaceæ
Sennæ Fructus (legume)	{ Cassia acutifolia { Cassia angustifolia	{ Leguminosæ
Solanum (Horsenettle-berries) (berry)	Solanum carolinense	Solanaceæ
Tamarindus (preserved pulp)	Tamarindus indica	Leguminosæ

In the study of the physical characteristics of fruits it is important to note the kind or type, occurrence, shape, external markings and color, internal appearance including presence or absence of dissepiments, number of cells, and character of seed, odor and taste.

The histological examination of a fruit should include a microscopical study of (a) the *pericarp*, (b) the *seed* and (c) the *placenta*. In some fruits *dissepiments* or partition walls are present dividing the interior of the ripened ovary into *locules*, as in capsicum and cardamom fruits. These should be separately examined. In other fruits, as those of the Nightshade family, the *calyx* which persists in the ripening of the pistil and adheres to the receptacle or to the ovary, must likewise be studied.

Frequently diagnostic features are to be found in the outer epidermis or epicarp and its underlying tissue, in the endocarp or inner layer of the pericarp, in the mesocarp or middle zone of the fruit wall or in the seed coat. The character of the cell contents including presence or absence of crystals or starch as well as the presence or absence of secretion cells or of internal glands or reservoirs often furnish clues helpful in selection and identification. See also under seeds.

In the case of dehiscent fruits like those of Cardamom, Prickly Ash, etc. which open to discharge their seeds and certain fleshy fruits like capsicum, colocynth, fig, the gourd fruits, hesperidia and strobiles, it is essential that the fruit wall and seed be sectioned and examined separately, but in most of the indehiscent fruits including the achenes and the cremocarps like anise, fennel, caraway, coriander, etc., the piperaceous fruits like black pepper and cubeb, where the seed coats are usually thin and the seed solitary, no such separation is necessary. In grains with adherent chaff like barley and oat, the adherent flowering glume and palea should be separated from the fruit and examined individually.

**Powdered Fruits.**—The main diagnostic elements to be sought in the examination of powdered fruits are pulp cells, epicarp and endocarp tissue, the epicarp usually having but few stomata, trichomes, crystals especially of calcium oxalate, aleurone, secretory cells, oil reservoirs, and reserve starch.

## SEEDS AND SEED PARTS

A seed is a fertilized and ripened ovule containing an embryo.

## A. Those official in the U.S.P. XIII. See part II.

TITLE	BOTANICAL ORIGIN	FAMILY
1. Exalbuminous Seeds		
Sinapis Nigra (Black Mustard)	{ Brassica nigra Brassica juncea	{ Cruciferae
2. Albuminous Seeds		
Cardamomi Semen (Cardamom Seed)	Elettaria Cardamomum	Zingiberaceae
Myristica (Nutmeg) (kernel)	Myristica fragrans	Myristicaceae

## B. Those official in the N.F. VIII.

1. Albuminous Seeds		
Areca (Betelnut)	Areca Catechu	Palmæ
Colchici Semen	Colchicum autumnale	Liliaceae
Delphinium (Larkspur)	Delphinium Ajacis	Ranunculaceae
Linum (Flaxseed)	Linum usitatissimum	Linaceae
Nux Vomica	Strychnos Nux-Vomica	Loganiaceae
Plantaginis Semen (Psyllium Seed)	{ Plantago Psyllium Plantago indica (P. arenaria) Plantago ovata	{ Plantaginaceae
Strophanthus	{ Strophanthus Kombé and S. hispidus	{ Apocynaceae
2. Cotyledons		
Kola (Cola)	Cola nitida or other spp. of Cola	Sterculiaceae
3. Powder prepared from Kernels		
Cacao (Cocoa)	Theobroma Cacao	Sterculiaceae

## C. Other medicinal seeds.

Annatto	Bixa orellana	Bixaceae
Amygdala Amara (Bitter Almond)	Prunus Amygdalus	Rosaceae
Amygdala Dulcis (Sweet Almond)	Prunus Amygdalus var. dulcis	Rosaceae
Coffea Tosta (Roasted Coffee)	{ Coffea arabica Coffea liberica	{ Rubiaceae
Ignatia (St. Ignatius Bean)	Strychnos Ignatii	Loganiaceae
Pepo (Pumpkin Seed)	Cucurbita Pepo	Cucurbitaceae
Ricinus (Castor Oil Seed)	Ricinus communis	Euphorbiaceae
Sinapis Alba (Yellow Mustard)	Brassica hirta	Cruciferae
Staphisagria (Stavesacre)	Delphinium Staphisagria	Ranunculaceae
Cydonium (Quince Seed)	Cydonia oblonga	Rosaceae
Physostigma (Calabar Bean)	Physostigma venenosum	Leguminosae
Fœnumgræcum (Fenugreek)	Trigonella Fœnumgræcum	Leguminosae
Tigilium (Croton Seed)	Croton tigilium	Euphorbiaceae
Semen Papaveris (Poppy Seed)	Papaver somniferum var. nigrum	Papaveraceae
Paste chiefly consisting of crushed seeds		
Guarana	Paullinia Cupana	Sapindaceae

Seeds should first be studied as to physical characteristics. These include occurrence, group, shape, size, external surface, internal appearance as viewed in cross section, odor and taste.

**Occurrence.**—Seeds are usually in the entire condition as most medicinal seeds, rarely broken, or crushed into a paste with water and molded into cylindrical sticks as Guarana, or as portions of seeds as in the case of Nutmeg, Mace and Kola.

**Group.**—The group to which a seed belongs depends upon whether the embryo or young dormant plant within the seed contains all or nearly all of the stored food within the seed coats when the seed is called *exalbuminous* or whether the stored food is mostly within the tissue outside of the embryo, the embryo taking up the smaller space within the seed coats, when the seed is called *albuminous*. Seeds of nearly all Monocotyledons and of a number of Dicotyledon families including the *Ranunculaceæ*, *Piperaceæ*, *Lauraceæ*, *Myristicaceæ*, *Menispermaceæ*, *Papaveraceæ*, *Loganiaceæ*, *Malvaceæ*, *Umbelliferae*, *Rhamnaceæ*, *Apocynaceæ*, *Caprifoliaceæ*, *Campanulaceæ*, *Flacourtiaceæ*, *Solanaceæ*, *Rubiaceæ*, and most of the *Euphorbiaceæ* are albuminous.

Among the Dicotyl families having exalbuminous seeds are the following: *Salicaceæ*, *Myricaceæ*, *Fagaceæ*, *Juglandaceæ*, *Cruciferae*, *Rosaceæ*, *Leguminosæ*, *Labiatae*, *Cucurbitaceæ*, *Valerianaceæ*, *Compositæ*, *Anacardiaceæ*, *Sapindaceæ*, *Aceraceæ*, *Myrtaceæ*. The group to which each official seed belongs is indicated in the preceding table.

**Shape.**—The shape varies from globular, as in Colchicum or Mustard seeds, to oblong or oblong-lanceolate as in Strophanthus, to oval or ellipsoidal, as in Nutmeg, planoconvex, as in Coffee, or reniform, as Physostigma, orbicular, as in Nux Vomica to irregularly tetrahedral in Staphisagria and Delphinium, compressed ovate in flax, flattened-elliptic or ovate in Pepo and angularly-ovate in Ignatia.

**External Surface.**—The external surface varies from smooth in Psyllium, Physostigma, Colchicum and Linseed to furrowed and grooved in Nutmeg, to grooved in Pepo, to coarsely reticulate, as in Delphinium and Stavesacre, to hairy, as in Nux Vomica and Strophanthus. There is a distinct raphe in Nux Vomica, Physostigma, Linum and Strophanthus.

**Internal Appearance.**—The internal appearance should include the features which are helpful in diagnosis as shape and position of embryo, color, character of broken or cut surface as oily, mealy, etc.

**Odor.**—The odor of a seed is best obtained by crushing and moistening with water. Some seeds like Pepo, Colchicum, Kola, Physostigma, Nux Vomica, Ignatia and Delphinium have no distinct odor, others like Strophanthus and the black and white Mustards and Bitter Almonds give a characteristic odor only when moistened. Coffee, Nutmeg, Cardamom and Cacao have a characteristic aromatic odor.

**Taste.**—The taste may be starchy as in Physostigma, sweet and oily as in Amygdala Dulcis, chocolate-like as in Cacao, aromatic and pungent as in Cardamom and Nutmeg, mucilaginous as in Pepo, Psyllium and Linum, astringent

gent as in Guarana and Kola, bitter as in *Strophanthus*, intensely bitter as in *Nux Vomica* and *Ignatia*, bitter and acrid as in *Colchicum Seed*, *Delphinium* and *Staphisagria*, to oily and acrid as in *Castor Oil Seed*.

**Histology.**—In the microscopic study of seeds, attention should be focused upon the following regions which may show diagnostic characteristics: seed coats and appendages (if present), perisperm, endosperm and embryo.

The seed coats vary from one, two or three depending upon the seed studied. If only one is present it is called the *spermoderm*, if two, the outer is termed the *testa* and the inner the *tegmen*. In some cases a third coat is present outside the testa which is termed the *arillus*, in *Cardamom* and *arillode*, as in *Mace*. The arillus may be either dry or succulent. It is succulent in *Euonymus* and *Celastrus*.

Seed coats vary in microscopic structure and in many cases furnish valuable clues in the diagnosis of the specimen. The chief tissue regions to be looked for in any seed coat are the *outer epidermis*, a *sclerenchyma layer*, a *pigment layer* and the *inner epidermis*. The outer epidermis may consist of *palisade cells* as in leguminous seeds or of mucilaginous cells which secrete a slimy adhesive film when placed in water as *Linseed*, *Psyllium Seed*, *Quince Seed*, *Watermelon Seed*, *Mustard Seeds*, etc. Its cells may be extended into hairs as in *Nux Vomica* and *Strophanthus*.

The sclerenchymatous zone may consist of one or more layers of stone cells or sclerenchyma fibers and attention should be given to the character of the thickening of the walls of these cells and to their contents.

The pigment layer may consist of one or more rows of cells which contain coloring matter and which are largely if not entirely responsible for the color of the seed.

The *perisperm* of any seed represents the matured nucellus. In many seeds this region consists of cells which have collapsed and whose walls are more or less obliterated. In other cases, as *Cardamom*, *Nutmeg*, etc., nourishment has been stored up in the cells and the region becomes diagnostic. In *Piperaceous* seeds, as those within the drugs *Cubeb* and *Pepper*, the perisperm is the largest and most diagnostic region within the seed coat.

The *endosperm* or matured embryo sac is usually well developed in albuminous seeds but in exalbuminous seeds may be shrivelled up and with walls more or less obliterated, the embryo containing the stored food.

It may show an outer proteid layer or layers containing aleurone grains, as in *Linum* and cereal seeds, the remaining inner layers containing starch or starch and oil, or proteid in the form of aleurone grains and oil may both occur in these cells, as in the *Castor* and *Croton* seeds.

The *embryo* in exalbuminous seeds takes up most of the area within the seed coat and consists usually of two fleshy cotyledons, and a reduced hypocotyl and epicotyl. In albuminous seeds the embryo occupies the smaller and the albuminous tissue (endosperm or perisperm or both) the larger space beneath the seed coat. In these it should be noted whether it is straight, as in *Plantago* seeds, curved, as in *Capsicum*, or folded as in *Cocoa* seeds. The reserve paren-

chyma should be particularly studied as to the character of its cell walls and cell contents.

**Powdered Seeds.**—Seed powders are generally characterized by the presence of an abundance of aleurone grains, reserve starch and fixed oil or fat and the absence of cork cells, stomata, chlorophyll parenchyma and sclerenchyma fibers. Those seeds which are lacking in reserve starch, as *Nux Vomica*, *Ignatia*, *Date*, *Brazil Nut*, etc., usually show carbohydrate in the form of thick reserve cellulose walls in the endosperm cells. These then become diagnostic elements when such seeds are powdered.

### TRICHOMES (PLANT HAIRS)

**Trichomes** are outgrowths of epidermal cells. See part II.

#### A. Official in the U.S.P. XIII.

TITLE	BOTANICAL ORIGIN	FAMILY
1. Non-glandular		
Gossypium Purificatum (Purified Cotton)	{ Cultivated varieties of Gossypium hirsutum and other spp. of Gossypium }	Malvaceæ

#### B. Official in the N.F. VIII.

Glandular and non-glandular Kamala ( <i>Rottlera</i> )	<i>Mallotus philippinensis</i>	Euphorbiaceæ
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#### C. Other Plant Hairs.

1. Non-glandular		
Kapok	<i>Ceiba pentandra</i>	Bombacaceæ
2. Glandular		
Lupulinum (Lupulin)	<i>Humulus Lupulus</i>	Moraceæ

### GUMS, MUCILAGE, RESINS, GUM RESINS, OLEORESINS AND BALSAMS

Gums are amorphous substances of plant origin which are either soluble in water or swell in contact with water to produce viscous colloidal solutions called mucilages. They consist of glucosidal acids combined either partly or completely with calcium, potassium and magnesium. When hydrolyzed by dilute mineral acids, gums are partly converted into sugars.

**Mucilages** are substances produced by the breaking down of cell walls or contents of plants which form thick, viscid, adhesive liquids with water.

**Resins** are amorphous solid or semisolid, fusible substances, insoluble in water but soluble in alcohol, ether, chloroform and fixed oils. They combine with alkalies to form soaps.

**Gum Resins** or **oleo-gum-resins** are natural mixtures of gum, oil and resin.

**Oleo-resins** are natural solutions of resin in volatile oils.

**Balsams** are mixtures of resins with cinnamic or benzoic acid or both and generally a volatile oil.

#### A. Official in the U.S.P. XIII.

TITLE	BOTANICAL ORIGIN	FAMILY
1. <del>Gums</del>		
Acacia (Gum Arabic)	{ Acacia Senegal or some other African spp. of Acacia }	Leguminosæ
Tragacantha (Gum Tragacanth)	{ Astragalus gummifer and other Asiatic spp. of Astragalus }	Leguminosæ
2. Dried mucilaginous substance		
Agar (Agar-agar)	{ Gelidium cartilagineum, Graci- laria confervoides and related red algæ }	Gelidiaceæ, etc.
3. Resins		
Resina (Rosin)	{ Pinus palustris and other Pinus species }	Pinaceæ
4. Oleo-gum-resin		
Myrrha (Myrrh)	{ Commiphora abyssinica, C. mol- mol, and other spp. of Commi- phora }	Burseraceæ
5. Balsams		
Balsamum Peruvianum (Peruvian Balsam)	Myroxylon Pereiræ	Leguminosæ
Balsamum Tolutanum (Tolu)	Myroxylon Balsamum	Leguminosæ
Benzoinum (balsamic resin) (Gum Benjamin)	{ Styrax Benzoin, Styrax tonkin- ensis and other spp. of Sect. Anthostyrax of genus Styrax }	Styraceæ
Styrax (Storax)	{ Liquidambar orientalis Liquidambar Styraciflua }	Hamamelidaceæ

#### B. Official in the N.F. VIII.

1. Gum		
Gummi Sterculiæ (Sterculia Gum)	{ Sterculia urens Sterculia villosa Sterculia tragacantha et al. spp. of Sterculia }	Sterculiaceæ
	{ Cochlospermum Gossypium et al. spp. of Cochlospermum }	Bixaceæ
2. Oleo-gum-resins		
Asafoetida (Asafetida)	{ Ferula Assafœtida Ferula foetida and some other spp. of Ferula }	Umbelliferae
Cambogia (Gamboge)	Garcinia Hanburyi	Guttiferae
3. Resins		
Guaiacum (Guaiac)	{ Guajacum officinale Guajacum sanctum }	Zygophyllaceæ
Mastiche (Mastic)	Pistacia Lentiscus	Anacardiaceæ

	TITLE	BOTANICAL ORIGIN	FAMILY
4.	Oleoresins		
	Copaiba (Copaiba Balsam)	So. Amer. species of <i>Copaifera</i>	Leguminosæ
	Terebinthina (concrete)	{ <i>Pinus palustris</i> and other spp. of <i>Pinus</i>	{ Pinaceæ
	(Turpentine)		
5.	Pectin		
	Pectinum	Citrus and <i>Malus</i> spp.	{ Rutaceæ Rosaceæ

### INSPISSATED JUICES, DRIED LATEX, TARS AND EXTRACTS

**Inspsissated Juices** are dried juices of plants.

**Latex** is a natural emulsion of varying composition and color found in special passages of plants known as latex cells and laticiferous vessels.

**Tars** are blackish oily substances produced by the destructive distillation of wood or coal.

**Crude Drug Extracts** are evaporated decoctions of various parts of plants.

All official in U.S.P. XIII except Kino N.F. and Gambir N.F.

	TITLE	BOTANICAL ORIGIN	FAMILY
1.	Inspissated Juice		
	Aloe (Aloes)	{ <i>Aloe barbadensis</i> , <i>A. Perryi</i> and <i>A. ferox</i>	{ Liliaceæ
	Kino (Gum Kino)	<i>Pterocarpus Marsupium</i>	Leguminosæ
2.	Dried Latex		
	Opium (Gum Opium)	{ <i>Papaver somniferum</i> and its var. <i>album</i>	{ Papaveraceæ
3.	Tars		
	Pix Pini (Pine Tar)	{ <i>Pinus palustris</i> , or other spp. of <i>Pinus</i>	{ Pinaceæ
	Pix Carbonis (Coal Tar)	Fossil plants (coal)	
	Pix Juniperi (Juniper Tar)	<i>Juniperus Oxycedrus</i>	Pinaceæ
4.	Extract		
	Gambir (Pale Catechu)	<i>Uncaria Gambir</i>	Rubiaceæ

### MISCELLANEOUS DRUGS OF VEGETABLE ORIGIN

#### A. Those official in the U.S.P. XIII.

	TITLE	BOTANICAL ORIGIN	FAMILY
1.	Sugar		
	Sucrosum	{ <i>Saccharum officinarum</i> <i>Beta vulgaris</i>	Gramineæ Chenopodiaceæ
2.	Starch		
	Amylum (Corn Starch)	<i>Zea Mays</i>	Gramineæ
3.	Camphor		
	Camphora (Camphor)	<i>Cinnamomum Camphora</i>	Lauraceæ
4.	Rice Polishings		
	Perpolitiones <i>Oryzæ</i>	<i>Oryza sativa</i>	Gramineæ
5.	Diatom frustules		
	Terra Silicea Purificata (Purified Siliceous Earth)	{ Spp. of <i>Surirella</i> , <i>Melosira</i> , <i>Pinnularia</i> , <i>Tabellaria</i> , <i>Cocconema</i> , etc.	{ Bacillariaceæ
6.	Mold Products		
	Penicillin Calcium	{ <i>Penicillium notatum</i> and <i>Penicillium chrysogenum</i>	{ Aspergillaceæ
	Penicillin Sodium		
	Penicillin Potassium		

**B. Those official in the N.F. VIII.**

TITLE	ZOOLOGICAL ORIGIN	FAMILY
1. Sclerotium Ergota (Ergot)	Claviceps purpurea	Hypocreaceæ
2. Spores Lycopodium	Lycopodium clavatum	Lycopodiaceæ
3. Dried Purified Latex Papain	Carica Papaya	Caricaceæ
4. Purplish red Powder Persio (Cudbear)	{ Spp. of Roccella, Lecanora and other } { Lichens }	{ Parmeliaceæ }
5. Excrescence Galla (Nutmeg)	Quercus infectoria	Fagaceæ

**C. Yeast.**

Saccharomyces Siccum (Dried Yeast) U.S.P.	Saccharomyces cerevisiæ	Saccharomycetaceæ
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**ANIMAL DRUGS****A. Those official in the U.S.P. XIII.**

TITLE	ZOOLOGICAL ORIGIN	FAMILY
1. Insect Coccus (Cochineal)	Coccus cacti	Coccidæ
2. Fixed Oils Oleum Morrhuæ (Cod Liver Oil) Oleum Morrhuæ Non-Destearinatum Oleum Hippoglossi (Halibut Liver Oil)	{ Gadus morrhua et al. spp. } { of Fam. Gadidæ } Hippoglossus hippoglossus	{ Gadidæ } { Pleuronectidæ }
3. Fats Adeps (Lard) Adeps Benzoinatus (Benzoinated Lard) Adeps Lanæ (Anhydrous Lanolin) Adeps Lanæ Hydrosus (Lanolin)	Sus scrofa var. domesticus Sus scrofa var. domesticus Ovis aries Ovis aries	Suidæ Suidæ Bovidæ Bovidæ
4. Waxy Substance Cetaceum (Spermaceti)	Physeter macrocephalus	Physeteridæ
5. Ox Bile Extract Extractum Fellis Bovis (Powdered Oxgall Extract)	Bos taurus	Bovidæ
6. Enzyme Pancreatinum (Pancreatin)	{ Sus scrofa var. domesticus } { Bos taurus }	{ Suidæ } { Bovidæ }
7. Glands Pituitarium Posterius (Posterior Pituitary) 'Thyroideum (Thyroid)	{ Domesticated animals } { used for food by man }	{ Bovidæ, } { Suidæ, etc. }
8. Waxes Cera Flava (Beeswax) Cera Alba (Bleached Beeswax)	Apis mellifera Apis mellifera	Apidæ Apidæ
9. Sugar Lactosum (Milk Sugar)	Bos taurus	Bovidæ
10. Albuminoid Substance Gelatinum (Gelatin)	Various animals	Bovidæ etc.



**11. Active Principles of Glands**

**Desoxycorticosteroni Acetas**  
 (from adrenal gland)  
**Thyroxinum** (from thyroid glands)  
**Epinephrina** (from adrenal gland)  
**Extractum Hepatis** (from liver)  
**Injectio Hepatis** (Liver Injection)  
**Liquor Hepatis** (Liquid Liver Extract)  
**Injectio Parathyroidei**  
**Hepar cum Stomacho**  
 (Liver with Stomach)  
**Estradiol**  
**Estradiol Benzoate**  
**Estronum**  
**Testosterone**  
**Testosteroni Propionas**  
**Methyltesteronum**  
 (Methyl Testosterone)  
**Progesterone**  
**Injectio Insulini** (Insulin)  
**Injectio Zinco-Insulini Protaminati**  
 (Protamine-Zinc-Insulin Injection)

Domesticated animals  
used for food by man

Bovidæ,  
Suidæ, etc.

**12. Defatted Wall of Stomach**

**Stomachus Pulveratus**

*Sus scrofa* var. *domesticus* Suidæ

**13. Sterile Intestinal Gut**

**Chorda Chirurgicalis** (Catgut)

*Ovis aries*

Bovidæ

**14. Sera**

**Serum Humanum Normale**  
(Normal Human Serum)

*Homo sapiens*

Hominidæ

**15. Plasma Humanum Normale**

**Citratum** (Normal Human Plasma)

*Homo sapiens*

Hominidæ

**16. Globulinum Immune Humanum**

(Human Immune Globulin)

*Homo sapiens*

Hominidæ

**17. Surgical Silk**

**Chorda Serica Chirurgicalis**  
(Silk Sutures)

**Chorda Serica Chirurgicalis Sterilis**  
(Sterile Silk Sutures)

{ *Bombyx mori*

{ Bombycidæ

**B. Those official in the N.F. VIII.****1. Insect**

**Cantharis** (Spanish Flies)

*Cantharis vesicatoria*

Meloideæ

**2. Saccharine Secretion**

**Mel** (Honey)

*Apis mellifera*

Apidæ

**3. Enzymes**

**Pepsinum** (Pepsin)

**Renninum** (Rennin)

*Sus scrofa* var. *domesticus*

Suidæ

*Bos taurus*

Bovidæ

**4. Charcoal**

**Carbo Animalis Purificatus**

(Purified Animal Charcoal)

Various animals

Bovidæ, etc.

## 5. Glandular Products

Corpus Luteum	{	Bos taurus	{	Bovidæ
Ovarium (Ovary)				
Residuum Ovarii (Ovarian Residue)	{	Ovis aries	{	Bovidæ
Pituitarium Anterius (Anterior Pituitary)				
Pituitarium Totum (Whole Pituitary)		Sus scrofa	{	Suidæ
Suprarenalum (Desiccated Suprarenal)				

## 6. Fat

Sevum Praeparatum (Prepared Suet)	Ovis aries	Bovidæ
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## 7. Sera

Serum Antimeningococcicum (Antimeningococcic Serum)
Serum Antipneumococcicum (Antipneumococcic Serum—Type Specific)
Serum Immune Morbillosi Humanum (Human Measles Immune Serum)
Serum Immune Scarlatinæ Humanum (Human Scarlet Fever Immune Serum)

## C. Other Animal Drugs

**Heparin Sodium N.N.R.** is a hydrated salt of a mixture of active principles obtained from the liver and lungs of domesticated animals used as food by man. It possesses the property of prolonging the coagulation time of blood in man and other animals. It is used as an anticoagulant in the form of a sterile solution which is injected intravenously.

**Absorbable Gelatin Sponge** (Gelofoam, Upjohn) **N.N.R.** is a sterile absorbable water-insoluble gelatin base sponge. It is used as a surgical sponge in the control of capillary bleeding. Before using, it should be moistened thoroughly with sterile isotonic sodium chloride solution or sterile thrombin solution.

**Crystalline Zinc Insulin Injection N.N.R.** consists of a clear solution of zinc insulin crystals which contains the active antidiabetic principle of the Islets of Langerhans of the pancreas combined with a small amount of zinc. It is used in the treatment of diabetes mellitus, being especially indicated for patients allergic to plain insulin.

## CHAPTER III

### THERAPEUTIC CLASSES OF DRUGS

**Adsorbents** are substances endowed with the property of attaching other materials to their surface without any chemical action. They are employed in diarrheal conditions, as protective dusting powders, cataplasms, or antidotes for poisoning, etc. Ex: Kaolin, Activated Charcoal, Animal Charcoal, etc.

**Analgesics** (anodynes) are agents which allay pain by depressing the sensory nerve centers. Ex: Acetanilid, Morphine, Acetylsalicylic Acid, etc.

**Anaphrodisiacs** are agents which are alleged to depress sexual desire. Ex: Potassium Bromide, Nitrates, etc.

**Anesthetics** (two types). *Local Anesthetics* act locally and depress sensory nerve endings so that pain is not felt. Ex: Cocaine, Benzocaine, Ethyl Chloride. *General Anesthetics* are agents which act centrally to abolish pain, produce unconsciousness and more or less completely relax the muscles. Ex: Ether, Chloroform, Ethylene, Nitrous Oxide, Cyclopropane, etc.

**Anhydrotics** (antidiaphoretics) are agents which check perspiration. Ex: Atropine, Belladonna, Agaricus, etc.

**Anodynes** are drugs which act on the sensory nervous system, either centrally or peripherally, to produce relief from pain. Ex: Belladonna, Stramonium, Hyoscyamus, Phenol, Menthol, etc.

**Antacids** are agents which neutralize excessive acidity in the alimentary canal. Ex: Sodium Bicarbonate, Milk of Magnesia and Magnesium Trisilicate. They are used to counteract hyperacidity, but this should not be confused with *acidosis* which is a decreased state of alkaline reserve of the blood.

**Anthelmintics** are agents used to expel (vermifuges) or kill (vermicides) intestinal worms. Ex: Santonica, Santonin, Chenopodium Oil, Thymol, Hexylresorcinol, Spigelia, Carbon Tetrachloride, etc.

**Antiasthmatics** are agents which relax the bronchial muscle with a subsequent dilatation of the bronchioles. Ex: Ephedrine, Adrenalin, Nitrites, Stramonium, Lobelia, etc.

**Antibiotics** are agents produced by or derived from living cells of molds, bacteria or other plants which destroy or inhibit the growth of microbes. Ex: Penicillin, Streptomycin, Tyrothricin.

**Antiemetics** (antinauseants) are agents which prevent or lessen the tendency to vomit. Ex: Cerium Oxalate, Cocaine, Bismuth Subnitrate.

**Antilithics** are agents which have been employed to prevent the formation of urinary and biliary calculi. Ex: Alkaline Waters, Lithium Salts, etc.

**Antiluetics** (antisyphilitics) are agents used in the prevention, treatment and cure of syphilis. Ex: Penicillin, Compounds of Arsenic, Bismuth, and Mercury.

**Antiperiodics** (antimalarials) are agents which modify or prevent the return of malarial fever. Ex: Cinchona and its alkaloids, quinine, quinidine, cinchonine and cinchonidine.

**Antiphlogistics** are agents which reduce inflammation of the serous membranes. Ex: Cataplasm of Kaolin, etc.

**Antipyretics** (febrifuges) are agents employed to reduce the temperature of the body. Ex: Antipyrine, Acetophenetidin, Aspirin, Aconite, etc.

**Antiseptics** are agents which either inhibit, check the growth of or kill microorganisms on living tissues. Ex: Alcohol, Mercuric Chloride, Acriflavine, Potassium Permanganate, etc. (All agents labeled "antiseptic" must be capable of destroying microorganisms.)

**Antisialagogues** are agents which diminish the flow of saliva. Ex: Tannic Acid, Atropine, etc.

**Antispasmodics** (calmatives or antihysterics) are agents which are used to quiet the spasms of voluntary and involuntary muscles. Ex: Chloroform, Asafoetida, Valerian, Sumbul, Viburnum Opulus, Viburnum Prunifolium, Thyme, etc.

**Antizymotics** (antifermentatives) are agents which arrest fermentation. Ex: Sodium Benzoate (0.1 per cent.), Thymol, etc.

**Aphrodisiacs** are agents which are alleged to stimulate sexual desire. Ex: Phosphorous, Nux Vomica, Strychnine, etc.

**Astringents** are agents which shrink, blanch, wrinkle and harden tissue, diminish secretions and exudates and coagulate blood. They have a characteristic "astringent taste," i.e., they produce a feeling of constriction or "puckering," drying and roughness in the mouth. Ex: Tannic Acid, Alum, Iron salts, Kino, Gambir, Krameria, Hematoxylon, etc.

**Bacteriostatics** are agents which tend to retard the growth of microorganisms, but do not kill them. Ex: Boric Acid, etc.

**Cardiac depressants** are agents which slow down the action and force of the heart, and lower blood pressure. Ex: Aconite, Veratrum Viride.

**Cardiac stimulants** (cardiac tonics) are agents which are used to restore cardiac efficiency and bring about an improvement of the circulation. Ex: Digitalis, Aromatic Ammonia Spirit, Strophanthus, Apocynum, Convallaria, Adonis, etc.

**Carminatives** are agents which are used to expel gas and relieve colic. Ex: Ginger, many volatile oils, Cardamom, Catnip, Anise, Fennel, Coriander, Peppermint, etc.

**Cathartics** are agents which cause an evacuation of the bowel. They may cause increased peristalsis by means of irritation or may act by increasing the bulk of the intestinal tract, or by virtue of their osmotic action. Ex: Castor Oil, Cascara Sagrada, Rhubarb, Epsom Salt, Frangula, etc.

**A. Cholagogue cathartics** are agents which stimulate the flow of bile, causing purgation with green colored and liquid stools. Ex: Ox Bile Extract, Podophyllum Resin.

**B. Drastics** (hydragogue cathartics) are cathartics which cause intense intestinal irritation, producing watery stools in profuse amounts. Ex: Bryony, Colocynth, Jalap, Gamboge, Ipomoea, Elaterin, etc.

**C. Laxatives and aperients** are agents which cause a more or less normal evacuation of the bowel without irritation or griping effects. Ex: Tamarind, Cassia Fistula, Manna, Senna, Sulfur, Phenolphthalein, etc.

**D. Mechanical laxatives** are agents which lubricate the intestinal tract and are not absorbed. Ex: Mineral Oil, Psyllium Seed, Sterculia Gum, etc.

**E. Purgatives** are cathartics which actively increase peristalsis, producing watery stools, or soft semifluid stools. Ex: Aloe, Rhubarb, Castor Oil, Cascara Sagrada, Frangula, etc.

**F. Saline cathartics** are certain inorganic and organic salts which produce evacuation of the bowels by virtue of their osmotic action, increasing the bulk and fluidity of contents of the intestinal tract. Ex: The salts of citric, sulfuric, phosphoric and tartaric acids.

**Caustics** (escharotics or corrosives) are agents which destroy tissue. Ex: Glacial Acetic Acid, KOH, Silver Nitrate, etc.

**Cholagogues** are agents that stimulate the emptying of the gallbladder and the flow of bile into the duodenum. Ex: Olive Oil.

**Choleretics** are agents which increase the production of bile in the liver. Ex: Fel Bovis, Sodium Glycocholate, Sodium Taurocholate.

**Circulatory stimulants** are agents employed in the treatment of failing circulation, as Digitalis, Ephedrine, Epinephrine, Apocynum, etc.

**Conspurgatives** are dusting powders or agents applied externally to prevent and allay irritation of the skin. Ex: Zinc Stearate, Talcum.

**Correctives** are medicines used to correct or render more pleasant the action of other remedies, especially purgatives. Ex: Hyoscyamus Tincture with a drastic purgative.

**Counterirritants** (irritants) are agents which cause irritation of the part to which they are applied and draw blood away from a deep seated area. Ex: Mustard, Capsicum, Plasters, etc.

**Cycloplegics** are drugs which paralyze accommodation of the eye. Ex: Atropine and Homatropine Hydrobromide.

**Demulcents** are agents used to soothe and protect mucous membranes. Ex: Acacia Mucilage, Althea, Milk, Bland Oils, etc.

**Dentifrices** are powders, pastes or liquids intended for application to teeth or gums by means of a tooth brush. Ex: Dentifricium, N.F., Prepared Chalk and Orris, etc.

**Deodorants** are agents used to absorb or destroy foul odors. Ex: Chlorinated Lime, Potassium Permanganate, etc.

**Depilatories** are substances employed to remove hair. Ex: Barium Sulfide.

**Diaphoretics** (hydrotics or sudorifics) are agents used to increase the perspiration. Ex: Dover's Powder, Pilocarpine, Eupatorium, Eserine, etc.

**Digestants** (digestive ferments) are agents used to aid in the digestion of foods. Ex: Pepsin, Pancreatin, Papain, Rennin, etc.

**Disinfectants** (germicides) are agents which destroy microorganisms on non-living materials. Ex: Strong solution of Phenol, Mercuric Chloride, Merthiolate, Iodine, Sulfa Drugs, etc.

**Diuretics** are agents used to increase the flow of the urine. Ex: Acetates, Citrates, Theobromine with Sodium Salicylate, Theophylline, Buchu, Chimonophila, etc.

**Ecbolics** (oxytocics) are agents used to stimulate the gravid uterus to the expulsion of the fetus, or to cause uterine contraction. Ex: Ergot, Ergonovine Maleate, Posterior Pituitary, Pitocin, etc.

**Emetics** are agents which cause vomiting. There are two types, namely, the *centric emetics* which act directly upon the vomiting center in the medulla, as Ipecac and Apomorphine HCl, and the *peripheral emetics* which act by irritating sensory nerve endings in the stomach and reflexly stimulate the vomiting center in the medulla, as Mustard, Zinc Sulfate, etc.

**Emmenagogues** are agents which reestablish or increase the menstrual flow. Ex: Iron preparations, Ergot, etc. Dysmenorrhea is painful menstruation and amenorrhea is suppressed menstruation.

**Emollients** are agents used externally to soften the skin and protect it. Ex: Cold Cream, Lanolin, Lotions containing Chondrus Mucilage, etc.

**Epispastics** are agents which when applied to the skin cause the formation of blisters. Ex: Cantharis and Strong Iodine Tincture.

**Escharotics** are substances which cause the death of tissue by chemical reaction with it. Ex: Caustic alkalies, Caustic acids, Vienna Paste, etc.


**Expectorants** are agents which cause expulsion of the mucus from the respiratory tract. There are two types, the *nauseating* expectorants which relax the bronchial blood vessels and increase the bronchial secretion as Ipecac, Cocillana, Tartar Emetic, etc., used in "dry" or "tight cough," and the *stimulating expectorants* which stimulate the dilated bronchial mucous membrane and tend to restore tone to blood vessels. Ex: Pine Tar, Turpentine, Terpin Hydrate, Tolu Balsam.

**Galactagogues** are agents which increase the lacteal secretion. Ex: Pilocarpine, Posterior Pituitary, Galega.

**Hematinics** (chalybeates or ferruginous tonics) are agents which improve the quality of the blood. This they do by increasing the number of red blood corpuscles and/or the percentage of hemoglobin. Ex: Iron Salts, Manganese, Arsenic, etc.

**Hemostatics** are agents used to stop internal hemorrhage. Ex: Ergot, Adrenalin, Stypticin (Cotarnine HCl).

**Hypnotics** are agents used to produce, induce or maintain sleep without delirium. Examples of hypnotics which do not abolish pain are potassium Bromide, Chloral, etc., while hypnotics which do abolish pain include morphine, opium, etc. *Delirifacients* are drugs which produce sleep with delirium, as Cocaine and Cannabis.

**Intoxicants** are substances that produce mental confusion followed by muscular incoordination. Ex: Alcohol in sufficient amounts. 

**Miotics** (myotics) are agents which constrict the pupil of the eye. Ex: Pilocarpine, Eserine (Physostigmine), etc.

**Motor Depressants** are agents which depress the functions of the spinal cord, motor nerves, and muscles. Ex: Physostigma, Gelsemium, Conium, etc.

**Motor Excitants** are agents which increase the functional activity of the spinal cord and increase muscular activity. Ex: Strychnine, Nux Vomica, Ignatia, etc.

**Mydriatics** are agents which produce a dilatation of the pupil of the eye. Ex: Belladonna, Atropine, Homatropine, Cocaine, etc.

**Narcotics** are drugs which relieve distress and induce sleep. In sufficiently large doses they produce a reversible stage of profound unconsciousness. Ex: Opium, Coca, Heroin and Dilaudid HCl.

**Oxytocics** (see ecbolics).

**Parasitocides** are agents which destroy animal or vegetable parasites. Ex: Sabadilla, Benzyl Benzoate, Rotenone, Larkspur, Fish Berry, Miré, etc.

**Protectives** are agents used locally to protect and soothe the skin and mucous membranes. They include the demulcents, emollients, dusting powders and mechanical applications.

**Pustulants** are agents which cause powerful irritation of the skin, particularly the sweat glands, producing pustules. Ex: Croton Oil.

**Refrigerants** are agents which allay thirst and give a sensation of coolness to the system. Ex: Dilute Mineral Acids, Mindererus Spirit, Fruit Juices, etc.

**Respiratory sedatives** are drugs used to allay troublesome or painful cough. Ex: Codeine, Morphine, etc.

**Respiratory stimulants** are drugs which stimulate the respiratory center, directly or reflexly. Ex: Aromatic Ammonia Spirit, Ether Spirit, etc.

**Rubefaciants** are agents which when applied to the skin produce mild irritation accompanied by reddening of the skin. Ex: Turpentine Oil, Iodine, Methyl Salicylate, Capsicum Tincture, etc.

**Sedatives** are agents which allay excitement and soothe the system. Ex: Cerebral sedatives, as morphine and opium. Nerve sedatives, as potassium bromide and barbiturates. Cardiac sedatives, as Aconite and Veratrum Viride. Gastric sedatives, as Bismuth salts and Cocaine. Respiratory sedatives, as Codeine, Morphine, etc. Arterial sedatives, as sodium nitrite, amyl nitrite, etc. Bronchial sedatives, as nitrites, atropine, etc. Uterine sedatives, as Viburnum Opulus, Viburnum Prunifolium, etc.

**Sialagogues** are agents which cause an increase in the flow of saliva. Ex: Pilocarpine, Pellitory Root, etc.

**Somnificants** (soporifics) are agents which produce sleep without delirium. Ex: Opium, Morphine, Dilaudid, etc.

**Sternutatories** (errhines) are agents which promote sneezing. Ex: Powd. Quillaja, Sanguinaria, etc.

**Stimulants** (cerebral) are agents which stimulate the activity of the cerebrum especially the higher centers of reason and thought, self-control, will, etc. Ex: Caffeine, Cannabis, etc.

**Stimulants** (general) are drugs which increase functional activity.

**Stomachics** are agents which are used to stimulate the appetite and gastric secretion. Ex: *Simple Bitters* as Gentian, Cinchona, etc.; *Aromatics*, as Cinnamon, etc.; *Aromatic Bitters* as Serpentaria, Asarum, Matricaria, etc. Simple bitters depend for their action upon the presence of a bitter principle, only; aromatics upon a contained volatile oil or other aromatic principle; aromatic bitters upon volatile oil and bitter principle.

**Styptics** are agents which are used externally to stop the flow of blood. Ex: Monsel's Solution, etc.

**Taenifuges** are agents used to expel tapeworms. Ex: Aspidium Oleoresin, Pomegranate Bark Decoction, Pelletierine Tannate, Koussou, etc. Taenicides are agents used to kill tapeworms.

**Tonics** are agents used to stimulate the restoration of tone to muscle tissue. Ex: Nux Vomica.

**Vasoconstrictors** are agents which cause a constriction of the blood vessels. Ex: Epinephrine, Ephedrine, etc.

**Vasodilators** are agents which cause a dilation of the blood vessels, and are used to relieve high blood pressure. Ex: Nitrites, Diluted Erythrityl Tetranitrate, Nitroglycerin Spirit, etc.

**Vesicants** (epispastics) are agents which when applied to the skin cause blistering and the formation of vesicles. Ex: Cantharides, etc.

## ALLERGENS

**Allergy** is a specific hypersensitivity of man to a foreign substance.

**Allergens** are substances which induce hypersensitiveness in allergically sensitized persons. In many individuals contact with or ingestion of certain substances into the respiratory or alimentary tract causes marked local or constitutional reactions or symptoms such as urticaria, hay fever, asthma, coryza, migraine, forms of eczema, arthralgia and angioneurotic edema. Many of the substances inducing this abnormal hypersensitivity or allergy have been found to be protein in character.

The chief allergenic materials have been found to be plant pollens, spores of fungi, bacteria, house dust, many foods, and the epidermal emanations from horses, cats and other animals.

## PLANT POLLENS

The pollens which induce allergy are chiefly those of wind-pollinated or anemophilous plants and include many grasses, weeds, trees and shrubs. However, not all anemophilous plants produce the characteristic allergenic symptoms known as hay fever or bronchial asthma. Most of the so-called hay-fever plants are found in the following families: *Aceraceæ* (maples), *Amaranthaceæ* (pigweeds), *Betulaceæ* (birches, alders, hazels), *Chenopodiaceæ* (Russian Thistle, saltbushes, goosefoots), *Compositæ* (ragweeds, artemisias, clotburs, goldenrods), *Cupressineæ* (arbor vitae, cypresses and junipers), *Fagaceæ* (beeches, chestnuts and oaks), *Juglandaceæ* (walnuts and hickories), *Moraceæ* (mulberries, hemp),



*Oleaceæ* (olive, privets and ashes), *Plantaginaceæ* (plantains) and *Polygonaceæ* (knotgrasses, docks and rhubarbs).

Surveys have been made in practically every state in the country in order to ascertain the kinds of pollen in the atmosphere and their abundance at different seasons of the year. These have proven of great value to physicians in ascertaining which plants are producing an abundance of pollen in a given region,



FIG. 6.—The Giant Ragweed, *Ambrosia trifida* L. (Fam. *Compositæ*). Upper portion of plant showing 3-lobed leaves and spikes of small greenish flower heads. One of the important hay fever plants which is common in the central United States and extends eastward.

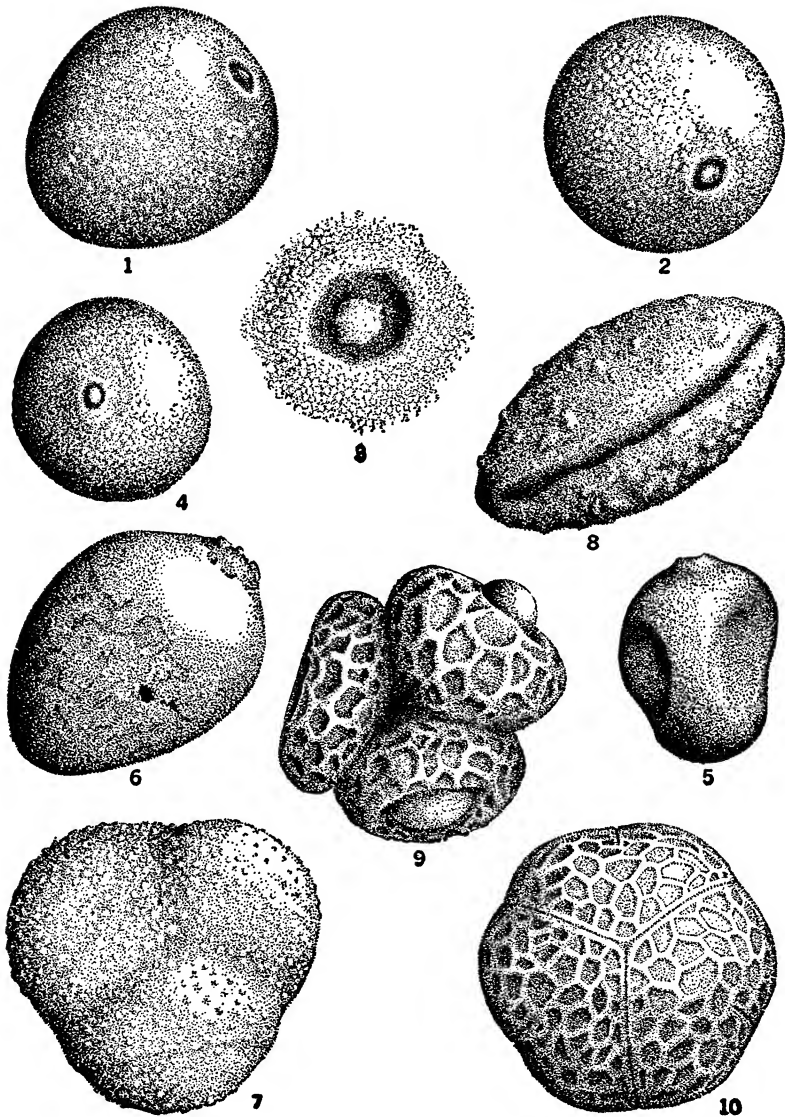


FIG. 7.—Pollen grains of *Gramineae*, *Cyperaceae*, *Juncaceae* and *Magnoliaceae*. 1. *Festuca elatior*, side view,  $32\mu$  in diameter. 2. *Phleum pratense* (Timothy), ventral view,  $35\mu$  in diameter. 3. Germ pore and surrounding exine of a pollen grain of *Avena fatua* (Wild Oat). 4. *Agrostis palustris* (Red Top), ventral view, expanded,  $28\mu$  in diameter. 5. The same, contracted. 6. *Carex stricta* (Tussock Sedge) side view,  $44\mu$  long. 7. *Juncoides campestris* (*Luzula campestris* or Common Wood Rush), whole tetrad,  $38\mu$  in diameter. 8. *Liriodendron Tulipifera* (Tulip Poplar), ventral view,  $40 \times 62\mu$ . 9. *Drimys Winteri* (Winter's Bark), each grain of the tetrad  $34.2\mu$  in diameter. 10. *Schizandra chinensis*, dorsal view,  $21.6\mu$  in diameter. (After R. P. Wodehouse, "Pollen Grains," 1st ed., McGraw-Hill Book Co., Inc., N.Y.)

in order that the number of allergic tests on his patients might be reduced to a minimum.

**Pollen Counts.**—The ordinary method used in obtaining a pollen count is to expose a micro-slide coated with glycerin jelly containing a small percentage of a dye such as basic fuchsin or with petroleum jelly (if the air be moist) to the atmosphere. The slide should be securely fastened to a support and protected against rain. After exposure for 24 hours, the slide is brought into the examination room and, after removing any coarse particles from it, it is gently warmed above a flame, a cover-glass applied, placed on the stage of a compound microscope, and the number of pollen grains of different kinds counted and recorded.\* For further details on methods of collecting and identifying pollens, see R. P. Wodehouse, "Hayfever Plants," published by Chronica Botanica Co., Waltham, 1945, and "Pollen Grains" by the same author, published by McGraw-Hill Book Co., New York, 1935; also, *Journal of Allergy*, 17 (3) 178 (May, 1946).

### ALLERGENIC PREPARATIONS

**Allergenic preparations** are either extracts or solutions of substances which induce hypersensitiveness and which are employed by physicians for the diagnosis, or prevention of allergic symptoms. They include pollen extracts, animal epidermal extracts, poison-ivy and poison-oak extracts, fungus extracts, bacterial extracts, plant and animal food extracts, orris-root extract, etc. They may be grouped into two classes, viz.: (1) those that produce a reaction when applied to the surface of the skin or mucous membrane and which may be determined by the "patch test" and (2) those which cause a reaction when introduced into the interior of the body and which may be determined by intradermal administration or by the "scratch test."

Among the allergenic preparations marketed are the following:

#### 1. Pollen extracts, concentrated pollen extracts and allergenic extracts.

For diagnostic purposes for use in skin testing concentrated solutions of pollen extracts are marketed in capillary tubes containing sufficient material for one test or in packages containing 1-cc. vials containing sufficient material for a number of tests or in sets of vials representing graduated concentrations. Dry pollens intended for carrying out diagnostic scratch tests are supplied in vials usually containing 50 mg.

#### 2. Poison Ivy, Poison Oak and other *Rhus* extracts or antigens

consist of extracts made with alcohol, ether or acetone of the leaves or leaves and twigs of various species of *Rhus* or a solution of concentrated extract in olive or almond oil with 2 per cent camphor or 0.5 per cent chloretone added as a preservative. They are available in packages containing 1-cc. vials or in packages containing one or more vials with vials containing a sterile diluent.

#### 3. Bacterial extracts

consisting of protein preparations of many kinds of bacteria are marketed in packages of vials containing graduated concentrations and dilutions of proteins of a large number of bacteria.

#### 4. Food, epidermal and fur extracts

consisting of protein extracts of a large

\* Pollen as well as mold counts are reported on the basis of the number of pollen grains or mold spores of each species found on one square centimeter of slide area.

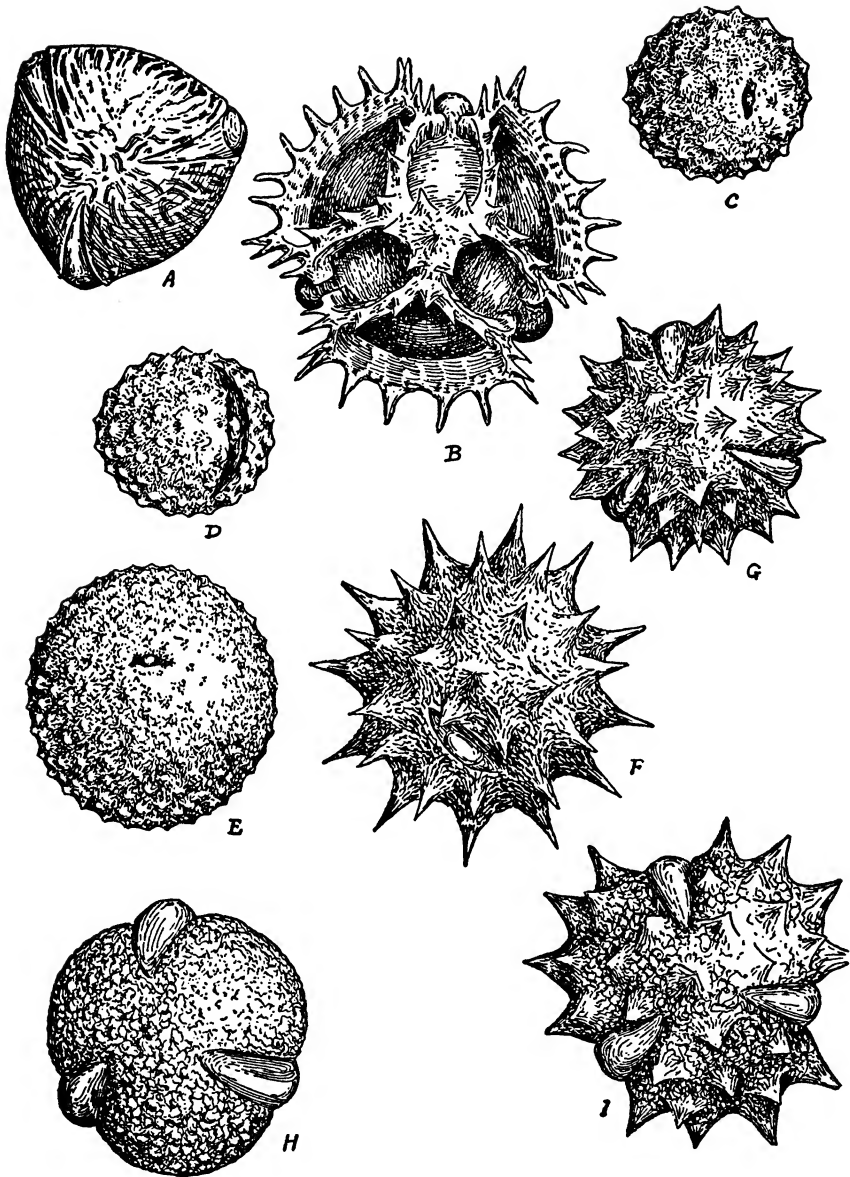


FIG. 8.—Pollen grains of the *Simarubaceæ* and *Compositæ*. A, Tree-of-Heaven (*Ailanthus*). B, Dandelion (*Taraxacum*). C, Short Ragweed (*Ambrosia elatior*). D, Prairie Ragweed or Burweed Marsh Elder (*Iva xanthiifolia*). E, Cocklebur (*Xanthium speciosum*). F, Sunflower (*Helianthus*). G, Goldenrod (*Solidago*). H, Sagebrush (*Artemisia tridentata*). I, Chrysanthemum. All magnified 1300 times. (After Wodehouse, "Hayfever Plants," *Chronica Botanica Co.*)

number of plant and animal materials including cereals, hairs, egg white, nuts, tomatoes and other fruits, feathers, fish, crab, lobster, pork, beef, lamb, etc. are available in vials or packages of vials of various concentrations and dilutions and, for use by the scratch test, in vials containing 15 to 50 mg. of the powdered protein material, or for intradermal testing, in vials containing a 1:500 solution of the protein material.

5. **Fungus extracts** including extracts of *Alternaria*, *Aspergillus*, *Monilia*, *Penicillium*, *Ustilago* and Yeast species are available in 2-cc., 5-cc., and 30-cc. vials.

### ANTIHISTAMINICS

**Antihistaminics** are substances which antagonize histamine and which are used for the relief of some allergic phenomena.

Histamine is an amine ( $C_5H_9N_3$ ) which is released in the tissues during certain allergic reactions. The fundamental mechanism involved in these reactions is believed to be the reaction which occurs when an antigen meets an antibody in the body cells. This antigen-antibody reaction liberates histamine or a substance closely resembling it. At this time, it has not been established with certainty that histamine is the only substance concerned in the mechanism of the allergic state. Moreover, while useful, the antihistaminics are only palliative.

Among the numerous antihistaminic agents on the market are the following: Benadryl ( $\beta$ -Dimethylaminoethyl benzhydryl ether, Parke-Davis), Pyribenzamine (N,N-Dimethyl-N'-benzyl-N'- $\alpha$ -pyridylethylenediamine, Ciba), Neohetramine (N, N-Dimethyl-N'-(*p*-methoxybenzyl)-N- $\alpha$ -pyrimidylethylenediamine, Nepara), Histadyl (Thenylpyramine HCl, Lilly); Thenylene HCl (Methapyrilene HCl, Abbott) (N, N-Dimethyl-N'-2-thenyl-N- $\alpha$ -pyridylethylenediamine), Trimetron (1-Phenyl-1- $\alpha$ -pyridyl-3-dimethylaminopropane, Schering), and Thephorin (2-Methyl-9-phenyl-2,3,4,9-tetrahydro-1-pyridindene, Hoffmann-La Roche).

Antihistaminics are usually administered in adult dosages, by mouth, of 25 to 50 mg., 2 to 4 times a day and locally in the form of ointments and creams. The available forms for internal administration are tablets, capsules, capseals, elixirs and syrups.

**Uses.**—In hay fever, seasonal and perennial allergic rhinitis, pruritis, atopic dermatitis, allergic eczema, vasomotor rhinitis, serum sickness and urticaria, also in certain drug reactions, as from sulfonamides, penicillin and barbiturates.

PART II

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TAXONOMIC CONSIDERATION  
OF  
DRUGS



## CHAPTER I

### DRUGS OF VEGETABLE ORIGIN

#### DIVISION I—THALLOPHYTA (THALLOPHYTES)

Plants, the greater number of which consist of a *thallus*, a body undifferentiated into root, stem or leaf. This group, nearest to the beginning of the plant kingdom, presents forms showing rudimentary structures which are modified through division of labor, differentiation, etc., in higher groups. Under the microscope the thallus shows neither tracheæ nor wood fibers. To this assemblage belong the bacteria, slime-molds, blue-green algæ, diatoms, green, brown and red algæ, fungi and lichens. The bacteria are believed to be the oldest and most primitive in organization of all plants. Their drug products are discussed under "Bacterial Biological Products," in Chapter III.

#### SUBDIVISION—ALGÆ

Low forms of thallophytes of terrestrial and aquatic distribution consisting for the most part of single cells or rows of single cells joined end to end to form filaments. The higher forms, however, possess structures, which might be compared to stems and leaves of higher plants, although more rudimentary in structure. All excepting the saprophytic forms contain chlorophyll, with the addition in blue-green, brown and red algæ of other pigments. Many of the blue-green and green algæ as well as the diatoms have been responsible for disagreeable tastes and odors in water supplies during certain periods of the year. The commercially important algæ are limited to the diatoms and marine forms of the brown and red groups. A number of the brown algæ such as the kelps and rockweeds represent an important source of iodine and have also been harvested for their potash content, as fertilizer. Because of their abundant mucilage content, some of the red algæ, as Irish Dulse and Chondrus, have long been used as demulcents and nutritives.

#### CLASS—BACILLARIEÆ OR DIATOMS

This class comprises several thousand species of unicellular plants called *Diatoms* which are found in fresh, brackish and salt water, forming much of the diet of small animals. While unicellular, they frequently are united in colonies. They all possess chromatophores containing chlorophyll but this green pigment is often obscured by the presence also of a brown pigment.

The most striking peculiarity of the group is the structure of the enclosing cell wall. This is in the form of a siliceous case consisting of two *valves* which fit into each other like the halves of a pill box. The valves, which are beautifully sculptured, are similar except that one is slightly larger than the other so as to



fit over it. Diatoms vary in form being either circular, linear, elliptical, cylindrical, rhomboidal, triangular or fan-shaped, etc. Some are borne on the ends of stalks, while others are held in gelatinous masses. Their siliceous skeleta are deposited constantly on the floor of ponds, rivers, lakes and seas, often in such abundance as to form Diatomaceous earths or Kieselguhrs (Siliceous Earths). Huge geological deposits of this material have been found in various parts of the world.

One of the largest of these is that at Richmond, Virginia. Many of the diatomaceous earths are useful as polishing powders and as absorbents for nitroglycerin in producing the explosive, dynamite. When purified they have been found valuable in pharmacy as filtering media for elixirs and aromatic waters.

#### PURIFIED SILICEOUS EARTH U.S.P. (TERRA SILICEA PURIFICATA)

**Synonyms.**—*Purified Kieselguhr, Purified Infusorial Earth.*

**Definition.**—A form of silica ( $\text{SiO}_2$ ), consisting of the frustules and fragments of diatoms, purified by boiling with diluted hydrochloric acid, washing, and calcining. It contains not more than 10 per cent. of water.

**Commercial.**—Crude siliceous earth (Kieselguhr) occurs in the form of rock masses in this country in the states of Virginia, Maryland, California, Oregon and Nevada. These are mined and the official (purified) article is calcined to destroy organic matter, washed, boiled with diluted hydrochloric acid, washed again and calcined. Preserve in well-closed containers.

**Description.**—A bulky, amorphous, very fine, white, light gray or pale buff powder without odor or taste, readily absorbing moisture and retaining about four times its weight of water without the mixture becoming fluid. It is insoluble in water, dilute solution of the alkali hydroxides, or in acids.

**Impurities.**—Samples of purified siliceous earth have been found which contained organic impurities, excess of moisture, water-soluble iron, sulfates and carbonates. If organic impurities be present, it is darkened appreciably upon ignition. More than 10 per cent. loss by weight, upon ignition, would signify excess moisture.

If effervescence occurs after 1 Gm. of sample is added to 25 cc. of diluted hydrochloric acid, *carbonates* are present; if this mixture be boiled for ten minutes, the water lost by evaporation replaced, and filtered and barium chloride test solution added, a precipitate or turbidity would indicate *sulfate*; if 10 Gm. of the sample are boiled with 50 cc. of water, replacing any water lost by evaporation, and filtered, and 5 drops of potassium ferrocyanide test solution be added to 5 cc. of the filtrate and a blue color develops, *water-soluble iron* is present.

**Microscopical Characteristics.**—Temporary mounts made in water or chloral hydrate solution show upon examination a variety of forms of frustules of diatoms. In some instances these are for the most part in the entire condition whilst in others they are more or less broken up.

**Uses.**—As a filtering medium and in the preparation of dermatologic pastes.

## CLASS—PHÆOPHYCEÆ, THE BROWN ALGÆ

Mostly marine forms showing great diversity in the form of their vegetative bodies. They occur for the most part in salt water between the high and low tide marks. Their bodies are usually fixed to some support in the water by means of a holdfast, and are often highly differentiated as to form and tissues. Some reach hundreds of feet in length as, for example, *Macrocystis*, which grows in the Pacific Ocean off the coast of California. Several, like *Fucus*, *Ascophyllum* and *Sargassum* (Gulf Weed), possess floating bladders containing oxygen. They all contain the brown pigment called *phycophæin* and the green pigment, *chlorophyll*, both of which are present in their chromatophores. A yellowish pigment called *phycoxanthin* has also been isolated from some of the species. Many of the kelps and rock-weeds belonging to this class have long been sources of iodine, potash and sodium.

The principal orders of brown algæ of pharmaceutical interest are the Laminariales or kelps and the Fucales or rockweeds.

## ORDER LAMINARIALES (KELPS)

The kelps constitute a group of brown algæ with large, flat, leaflike fronds found attached to rocks or other objects in the oceans by means of a holdfast. They show alternation of generations in their life histories, the asexual plant or sporophyte being large and conspicuous, the sexual plants being minute. The sporophyte produces cylindrical sporangia on the surface of the thallus in which zoospores are formed. The zoospores give rise to male and female gametophytes. The male plant consists of a minute filament bearing antheridia in which antherozoids are formed. The female plant consists of a few rounded cells or a single cell, any cell of which may develop into an oogonium containing a single egg. Upon fertilization of the egg by an antherozoid, a zygote is formed which develops into the large, conspicuous sporophyte or asexual plant. The important economic kelps are *Laminaria saccharina* and *L. digitata* occurring along the Atlantic coast and the *Macrocystis pyrifera* and *Nereocystis Luetkeana*



FIG. 9.—The kelp *Laminaria saccharina* or Devil's Apron, a source of iodine and algin.

of the American Pacific coast. All of these are capable of yielding kelp meal and algin.

### LAMINARIACEÆ FAMILY

Sporophyte simple, consisting of basal holdfast, stipe and a lamina which is either simple or digitate, Sori on both surfaces of lamina. Laminaria.

### LESSONIACEÆ FAMILY

Sporophyte more or less compound and composed of holdfast, branching stipe and few to numerous laminae. *Macrocystis*, *Nereocystis*.

### SODIUM ALGINATE N.F. (SODII ALGINAS)

**Synonym.**—Algin.

**Botanical Origin.**—*Macrocystis pyrifera* (Turn.) Ag., *Laminaria saccharina* (L.) Lamouroux, *Laminaria digitata* (L.) Edmonson, and *Nereocystis Luetkeana* (Mert.) Postel and Ruprecht.

**Part Used.**—The purified carbohydrate product extracted by the use of dilute alkali.

**Purity Rubric.**—Not more than 15 per cent of moisture, not less than 18 per cent and not more than 24 per cent of ash, not more than 1 mg. of insoluble matter in 0.5 Gm. of drug.

**Habitat.**—The Laminarias are native to the Atlantic Coast of northern U.S. and Canada. *Macrocystis* and *Nereocystis* are native to the Pacific Coast of North America.

**Plants.**—*Macrocystis pyrifera*, the California Giant Kelp, is a perennial brown alga growing along the Pacific coast of North America attached to rocks by means of a large conical holdfast composed of long, compactly branched haptera. A stipe arises from the holdfast which divides near its base into 4 or 5 branches, each of which bears unilateral blades and, near its base, a spherical or fusiform air-bladder. The blade is lanceolate, up to 80 cm. in length, denticulate along the margins, short stalked, the stalk bearing an air-bladder (pneumatocyst) near its base.

*Nereocystis Luetkeana*, the Bladder Kelp or Ribbon Kelp, is an annual kelp, attaining a length of about 100 ft. and occurring like *Macrocystis* in extensive beds. It possesses a hemispherical holdfast of compacted haptera, an elongated stipe terminating in a subglobular air-bladder and 4 flattened dichotomous branches. The branches bear up to 64 entire, smooth, lanceolate blades, up to 10 ft. or more in length and up to a foot in width.

*Laminaria saccharina* occurs on rocks along the Atlantic coast from Massachusetts to Newfoundland. Its stipe is up to 0.5 m. in length, the lamina lanceolate to oblong and exceeding the stipe, thin when young, but becoming thick, bullate and ruffled, mucilaginous.

*Laminaria digitata* occurs along the north Atlantic coast from Long Island and Connecticut to southern Massachusetts to Nova Scotia, the lower St. Lawrence to Hudson Bay. It is a perennial brown kelp with a heavy, closely

fibrous holdfast, stout stipe up to 6 dm. in length and a blade which when full grown is 8 to 12 dm. in length, subcordate below and deeply cleft into numerous flat segments above, the segments bearing scattered sori.

**Production and Commerce.**—The kelps are gathered (1) by means of a motor-run barge equipped with a modified mowing machine carrying a horizontal cutting blade which is placed in the bow of the boat, and a chain elevator arranged to hoist the kelp on board the boat, or (2) by hand through the use of large scythes from scows. *Macrocystis* is harvested between Cedros Island, Mexico and Point Conception, California. *Nereocystis* is harvested along the central California coast and northward, the Puget Sound being a rich source of supply. The *Laminarias* are harvested from June to December chiefly off Nova Scotia and to a lesser extent off the New England coast to Cape Cod. They are collected by power boats equipped with grapples which are hauled at a depth of 10 to 15 ft. from the boat and also by sickling or hand dragging from a dory.

**Description.**—Sodium Alginate occurs as a yellowish white powder which is nearly odorless and tasteless. It is soluble in water, forming a viscous colloidal solution, insoluble in alcohol and hydro-alcoholic solutions in which the alcoholic content is greater than about 30 per cent by weight and in acid solutions having a pH lower than about 3.

**Constituents.**—Chiefly the sodium salt of alginic acid, a polyuronic acid.

**Uses.**—As a suspending agent in pharmaceutical compounding, in lotions, emulsions, hair pomades, etc., for the stabilization of ice creams, and as a sizing for paper and textiles.

#### FUCACEÆ OR ROCKWEED FAMILY

The highest evolved group of brown algæ in which the male sexual organs (antheridia) and female sexual organs (oögonia) are lodged in conceptacles. Their sporophytes are perennial, the holdfasts disk-shaped and the fronds flattened.

#### FUCUS (FUCUS)

**Synonyms.**—Bladderwrack, Bladder Fucus, Sea-wrack, Black-tang; *Ger.* Blasentang, Meeriche, *Fr.* Fucus vesiculeux.

**Botanical Origin.**—*Fucus vesiculosus* Linné, *Ascophyllum nodosum* (L.) Le Jolis (*Fucus nodosus* Linné), *Fucus serratus* Linné, or *Halidrys siliquosa* Lyngb. (*Fucus siliquosus* L.).

**Part Used.**—The dried thallus.

**Habitat.**—Along coasts and borders of inlets of the North Atlantic Ocean between low and high tide marks.

**Plants.**—*Fucus vesiculosus*, the most common rockweed along the North Atlantic coast, occurs as a flat, mucilaginous, olive-brown thallus, which forks repeatedly, a type of branching called dichotomous. It grows near the surface of sea water, attached to rocks or to mussels along banks by means of a basal *disk-shaped holdfast*. In the upper branches of the thallus are to be found *air*

*bladders* which are more or less spherical and usually in pairs. The tips of old branches which become swollen and filled with gelatinous matter are termed *receptacles*. They are oval, heart-shaped or forked and are dotted over with minute orifices which communicate with cavities called *conceptacles*. Within these conceptacles of some of the plants the *antheridia*, or male sexual organs



FIG. 10.—*Fucus*. In center, *Ascophyllum nodosum*; on either side, *Fucus vesiculosus*. R, receptacle, B, bladder,  $\times \frac{1}{2}$ . Note the swollen receptacles on the sides of the branch of *Ascophyllum* and the bladders arranged singly.

are produced, while in conceptacles of other plants *oögonia*, or female sexual organs, arise. The conceptacles also contain numerous branching filaments called *paraphyses*, which arise from the cells lining the cavities.

*Fucus serratus*, rare along the Atlantic coast of America but common in European waters, has a frond which is distinctly serrated along the margin but no air-vesicles. Its receptacles are serrated, flattened and pointed.

*Ascophyllum nodosum*, formerly known as *Fucus nodosus*, is next in abundance to *F. vesiculosus*. It is found along the Atlantic seaboard only above

New York. It is characterized by a strap-like, leathery, repeatedly branched frond which is devoid of a midrib and distended at intervals by large, single, oblong air-bladders and by the occurrence of numerous ovoid or ellipsoidal receptacles along the sides of the main axis and its branches.

*Halidrys siliquosa*, formerly known as *Fucus siliquosus*, occurs in the Atlantic Ocean off the shores of Norway, England and France to the Fortune Islands, in the Adriatic Sea and off the coasts of China and Japan. Its frond is linear, olive green, compressed and pinnated irregularly with spreading branches in a distichous fashion, the branches as well as the main stem showing linear-lanceolate vesicles supported on little stalks. The receptacles occur at the ends of the branches and are linear-lanceolate.

**Description.**—The dried article constituting the drug occurs in the entire condition or in segments thereof. The thallus is flattened, dichotomously branched, brownish black to slightly reddish, usually with a slight, whitish incrustation and attains a length of up to 1 meter. A midrib extending throughout the forked frond may be present or absent. The margin is entire, wavy, or serrate. On either or one side of the midrib occur spherical, oval to ellipsoidal-shaped bladders which contain oxygen and other gases. The receptacles occur as swollen, ovate to ellipsoidal, often forked structures on the ends of some of the branches. The color is blackish brown; the odor seaweed-like; the taste, saline, mucilaginous and nauseous.

**Histology.**—Sections of *Fucus vesiculosus* cut outside of the receptacles exhibit a layer of colorless, epidermal cells polygonal in surface view, a hypodermis of about 4 rows of longitudinally elongated mucilaginous cells, the remaining central tissue consisting of loosely arranged pseudo-parenchyma with large intercellular air-spaces.

Sections through the receptacles exhibit spherical conceptacles containing either antheridiophores bearing pyriform antheridia and sterile cells or rounded oogonia separated by paraphyses.

**Powdered Drug.**—Reddish brown; numerous fragments of epidermis with polygonal cells, elongated hypodermal cells and irregular fragments of pseudo-parenchyma with thick mucilaginous walls.

**Constituents.**—A gelatinous substance termed *algin*, iodine up to 0.21 per cent in fresh material, bromine, chlorides, mannite and about 0.1 per cent volatile oil.

**Uses.**—Bladderwrack has been used in obesity because of its iodine content. It is now chiefly employed as a source of its mucilage.

**Average Dose.**—0.6 Gm. (10 grains).

**Preparation.**—Fluidextractum Fuci (unoff.), 0.6 cc. (10 minims).

#### CLASS—RHODOPHYCEÆ, THE RED ALGÆ

A greatly diversified group comprising marine algæ but represented also by some fresh-water forms. The marine red algæ are generally found below the low water mark. Their vegetative bodies vary from simple branching

filaments through all gradations to forms differentiated into branching stems, holdfasts and leaf-like organs. It has been observed that many of the higher types are composed of numerous filaments which are arranged so closely and connected so intimately by protoplasmic processes as to resemble the tissues of higher plants. Their color may be red, purple, violet, or reddish-brown



FIG. 11.—Irish Dulse (*Rhodymenia palmata*), a purplish-red, flat, membranous, dichotomously branched, red alga found along the northern shores of Atlantic Ocean between low and high tide marks.

or even green and is due to the presence of phycoerythrin, a red pigment, which is found in the chromatophores with but frequently masking the chlorophyll.

#### GIGARTINACEÆ FAMILY

A family of red, purple or violet colored Rhodophyceæ with a more or less fleshy thallus, irregularly or dichotomously lobed. They are usually gelatinous forms with flattened, furcate bodies. The cystocarps or spore-bearing organs are either imbedded in the flat portions of the thallus, as in *Chondrus crispus*, or borne on short tuberculated projections arising from the upper segments, as in *Gigartina mamilliosa*.

## CHONDRUS N.F. (CHONDRUS)

**Synonyms.**—*Irish-moss*, Carrageen, Salt Rock Moss; *Ger.* Knorpeltang; *Fr.* Mousse perlée.

**Botanical Origin.**—*Chondrus crispus* (L.) Stackhouse and *Gigartina mamillosa* (Goodenough et Woodward) J. Agardh.

**Part Used.**—The dried bleached plant.

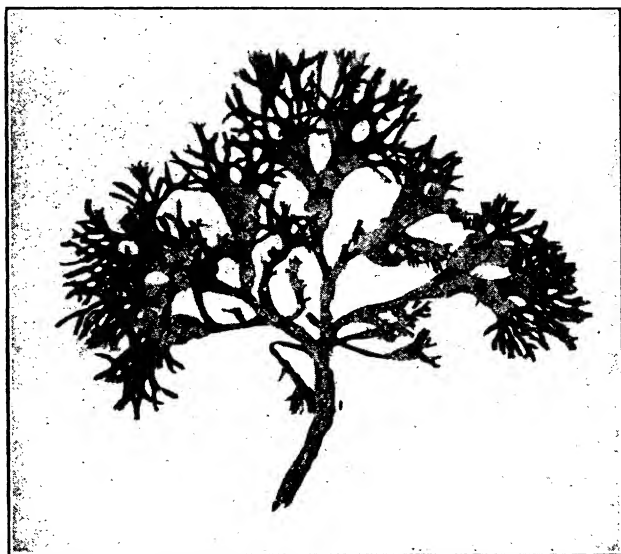


FIG. 12.—Irish Moss coated with a calcareous deposit.

**Purity Rubric.**—Not more than 2 per cent of foreign organic matter; no more than 2 per cent of acid-insoluble ash.

**Plants.**—*Chondrus crispus*, when fresh, varies from 3–25 cm. in length. It consists of a flat frond with a slender stalk (stipe) attached to the rock by means of a disk-shaped holdfast. The frond varies in color from greenish-purple to purplish-red or purplish-brown. In rough shallow water it is often pale yellowish-green. It is divided dichotomously into several wedge-shaped segments. These are repeatedly forked and terminate in a number of notched or 2-lobed segments. The fruiting bodies are ovate cystocarps.

*Gigartina mamillosa*, when fresh, somewhat resembles *Chondrus crispus*. It is purplish with a tinge of green. Its frond is irregularly branched in dichotomous fashion, the branches being forked at the apex. Its fructifications consist of small, more or less spherical, slightly elongated, sessile, bright red sporangia, borne on tuberculated stalks, which are scattered over the primary and secondary branches.

**Habitat.**—In the Atlantic Ocean growing on submerged rocks at or beyond the low water mark, off the coast of New England and Ireland, and from the shores of Norway to Gibraltar.



**Commercial.**—Most of the *Chondrus crispus* used in the United States is gathered along the coast of Massachusetts from 15 to 25 miles south of Boston, especially at Scituate, Mass., while some of the *Gigartina mamillosa* is collected along the coast north of Boston. Both plants are collected from the latter part

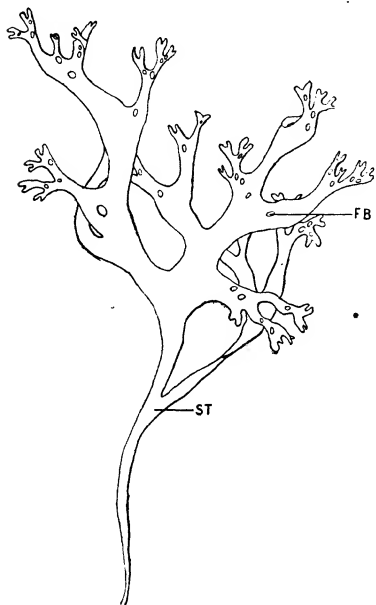


FIG. 13.—*Chondrus crispus*. (Irish Moss).  
Fruiting body (FB); stipe (ST).

of May until September, although the greatest harvest is reaped in June and July. The collectors go out in boats with long steel rakes and scrape the algæ off the rocks. They bring large quantities of it ashore and spread it out on the higher parts of the beach. Here it is exposed to the action of the sun and dews for a week or more and partially bleached. At the end of a week, after it has been turned over two or three times, it has assumed a pale purplish-yellow color. It is then placed in barrels which are filled with salt water and covered with canvas. These barrels are rolled to the beach and the alga again spread out to be further bleached. It is then raked over until dry and until the alga is of a pale yellowish color. It is stored in barns and later packed in barrels holding about 100 pounds, for shipment into the market. During 1941 about 660,000 lbs. of dry Irish Moss was produced at Scituate, Mass. The article has also been

imported from Dublin, Ireland, and Nîmes, France.

**Description.**—Entire plants more or less matted together, consisting of a slender stalk from which arises a series of dichotomously branching, somewhat flattened segments, notched or deeply cleft at the tips; from 5 to 15 cm. in length, and 1 to 10 mm. in width; yellowish-white, occasionally with a tinge of purple or red, translucent, often coated with a calcareous deposit; sometimes with fruit bodies (sporangia) embedded near the apex of the segments (*Chondrus crispus*), or, with sporangia borne on short tuberculated projections, scattered over the upper portion of the segments (*Gigartina mamillosa*); cartilaginous; odor seaweed-like; taste mucilaginous, saline.

**Identity Tests.**—When 1 part of *Chondrus* is boiled with 30 parts of water for ten minutes (the water lost by evaporation being replaced), the strained liquid forms a thick jelly upon cooling. When softened in cold water, *Chondrus* becomes gelatinous and transparent, the thallus remaining nearly smooth and uniform and not swollen except slightly at its tips.

**Tests for Adulterants.**—1. *Sulfites.*—When 5 Gm. of *Chondrus* are warmed with 30 cc. of water and 5 cc. of phosphoric acid in a flask, a purplish blue color

developed within 15 minutes on potassium-iodate-starch paper suspended in the flask above the fluid would indicate sulfites.

2. *Gelatin and Starch*.—When 0.3 Gm. of Chondrus is boiled in 100 cc. of water for 1 minute, the mixture filtered and cooled, the filtrate will produce a precipitate on the addition of tannic acid T.S., if gelatin be present, and a blue color upon the addition of iodine T.S., if starch be present.

**Constituents**.—*Carrageenin* (a mucilaginous principle), compounds of sodium, magnesium, potassium and calcium with chlorine, iodine and bromine; proteins, etc.

**Uses**.—Demulcent and nutrient; in the form of its mucilage as an emollient, demulcent, emulsifying agent and as a vehicle in various skin lotions and jellies.

**Preparations**.—Chondrus Mucilage (*Mucilago Chondri*), N.F.

**Product**.—A dry powdered Irish-moss extractive or hydrocolloid is obtained by extracting Chondrus in hot water, clarifying the liquid extract and drum drying or by precipitation with alcohol. This is used for thickening, gelling, emulsifying and suspending, also, in place of Chondrus, in preparing Chondrus Mucilage.

#### GELIDIACEÆ FAMILY

Branched, cartilaginous plants whose axes consist chiefly of long cylindrical cells arranged around a central siphon, the surface cells being polygonal; antheridia in superficial clusters; the cystocarps embedded in swollen branches and provided with two pores: carpogonia oblong or pear-shaped and produced on axile placentas: sporangia scattered in cortex.

#### AGAR. U.S.P. (AGAR)

**Synonyms**.—*Agar-Agar*, Vegetable Gelatin, Japanese or Chinese Gelatin, Japanese Isinglass. *Fr.* Mousse de Chine; *Ger.* Thav.

**Botanical Origin**.—*Gelidium cartilagineum* (Linné) Gaillon and from related red algæ.

The most important related red algae are *Gracilaria confervoides* (L.) Greville and *Hypnea musciformis* (Wulf.) Lamour. yielding Atlantic Coast Agar and *Ahnfeltia plicata* (Huds.) Fries and *Gelidium Amansii* Lamouroux which with *G. cartilagineum* yield Pacific Coast Agar.

**Part Used**.—The dried, hydrophilic, colloidal substance.

**Purity Rubric**.—Agar contains not more than 1 per cent. of foreign insoluble matter, not more than 1 per cent of foreign organic matter, and yields not more than 6.5 per cent of total ash, on a dry weight basis, not more than 0.5 per cent. of acid-insoluble ash on a dry weight basis and not more than 20 per cent. of moisture.

**Habitat**.—*Gelidium cartilagineum* and other spp. of *Gelidium* are native to the Japan, Yellow and China seas, along the eastern coast of Asia, and in the Pacific ocean, along the coast of California. *Gracilaria confervoides*, the chief species yielding Atlantic Agar, is native to the Atlantic Ocean along the eastern coast of the United States.

**Production and Commerce.**—Various species of *Gelidium*, *Gracilaria* and *Eucheuma*, etc. yield agar. The algæ are collected in summer and autumn along the coast of Eastern and Southern Asia, California, North Carolina and Australia, spread out on the beach until bleached and dried. During the winter months, they are then boiled with water and the mucilaginous liquid separated by straining through a cloth. The strained liquid is then cooled, the jelly cut into strips and dried by exposure to the air and sun, in the cold, to prevent growth of bacteria and molds. Most of the agar used in the United States before the World War came from Japan. During 1939, 497,077 pounds were imported from that country. During 1946, the importations of agar were only 87,332 pounds which can largely be ascribed to the increase in production of Agar in the United States. American Agar is manufactured at San Diego, Los Angeles, Whittier and Orange, California, from red algæ, chiefly, *G. cartilagineum*, growing along the coast of lower California and at Beaufort, N.C. from *Gracilaria confervoides* and *Hypnea musciformis* growing along the coast of North Carolina. Australian Agar is yielded chiefly by *Gracilaria confervoides*. California now supplies about 35 per cent of the agar normally used in this country.

**Description.**—Agar occurs mostly in bundles which consist of thin, translucent, membranous, agglutinated pieces from 4 to 10 mm. in width; or cut, flaked or granulated; externally weak yellowish orange, yellowish gray, pale yellow or colorless, tough when damp, brittle when dry; odorless or with a slight odor; taste mucilaginous. Insoluble in cold water but slowly soluble in hot water.

**Identity Tests.**—When Agar is boiled with 65 times its weight of water for 10 minutes, with constant stirring and adjusted to 1½ per cent by weight with hot water, it forms a clear liquid which congeals at 32° to 39°C. to form a firm resilient gel, which does not melt below 85°C. Iodine T.S. colors some of the fragments of agar bluish-black with some areas reddish to violet.

**Microscopical Characteristics.**—A fragment mounted in water gradually becomes more transparent, showing a granular and somewhat filamentous structure and a few diatoms. The most diagnostic diatom is *Arachnoidiscus Ehrenbergii* which is disk-shaped and from 100 to 300µ in diameter. This occurs only in Japanese Agar and identifies that variety. A quick method in finding diatoms in agar is to boil some of the material in water to the consistency of a mucilage and mount some of the latter. Spicules of sponges or fragments thereof and starch grains of algæ are also evident in some fragments of the drug.

**Powdered Drug.**—White to yellowish white or pale yellow. Under the microscope water mounts show a large number of irregular, angular fragments of dried mucilage, occasional diatom skeletons, swollen starch of the *Gelidiaceæ*, and sponge spicules.

**Constituents.**—About 65 per cent. of *gelose* (a mucilaginous substance, which, according to Takao, yields galactose with small quantities of fructose and arabinose, on hydrolysis and mucic acid on oxidation), nitrogenous substances, etc.

**Uses.**—As a laxative and in the preparation of culture media for bacteriologic and mycologic work. It is also employed as a constituent of some ice creams, candies and jellies, in baked goods, and for clarifying liquors, as a size, etc.

**Average Dose.**—4 Gm. (1 drachm).

**Adulterants.**—Foreign starch, gelatin, and foreign insoluble matter.

**Tests for Purity.**—*Foreign Starch.*—A solution made by boiling 100 mg. of Agar in 100 cc. of distilled water upon cooling does not produce a blue color upon the addition of iodine T.S.

*Gelatin.*—Dissolve 1 Gm. of Agar in 100 cc. of boiling distilled water and allow to cool to about 50°C. To 5 cc. of the solution add 5 cc. of picric acid T.S. No turbidity appears in 10 minutes (*gelatin*).

*Water Absorption Test.*—Place 5 Gm. of Agar in a 100-cc. graduated cylinder, fill to the mark with water, mix well and allow to stand at 25°C. for 24 hours, pour the contents of the cylinder through moistened glass wool, allowing the water to drain into a second 100 cc. graduated cylinder: not more than 75 cc. of water should be obtained.

*Foreign Insoluble Matter Test.*—Boil 7.5 Gm. of Agar in sufficient water to make 500 Gm., for 15 minutes, and readjust to the original 500 Gm. To 100 Gm. of the uniformly mixed material add hot water to make 200 cc., heat almost to boiling, filter while hot through a tared Gooch crucible, rinse the container with several portions of hot water, and pass these rinsings through the crucible. Dry the crucible and its contents at 105°C. to constant weight; not more than 1 per cent of residue remains, calculated on the dry weight basis of the 1.5 Gm. of agar represented.

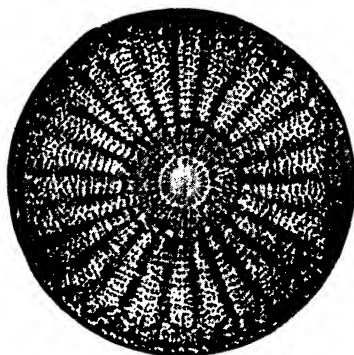


FIG. 14.—*Arachnoidiscus Ehrenbergii*, a diatom found in Japanese Agar,  $\times 185$ .

## SUBDIVISION—FUNGI

This great assemblage of thallophytes is characterized by the total absence of chlorophyll and so its members possess no independent power of manufacturing food materials such as starches, sugars, etc., from  $\text{CO}_2$  and  $\text{H}_2\text{O}$ . Consequently they are either *parasites*, depending for their nourishment upon other living plants or animals, called *hosts*; or *saprophytes*, depending upon decaying animal or vegetable matter in solution. Some forms are able to live either as saprophytes or parasites, while others are restricted to either the parasitic or saprophytic habit. The vegetative body of a fungus is known as a *mycelium*. It consists of interlacing and branching filaments called *hyphæ*, which ramify through decaying matter or invade the tissues of living organisms and derive nourishment therefrom. In the cases of parasites, the absorbing connections which are more or less specialized and definite are called *haustoria*. In the

higher forms the hyphæ become consolidated into false tissues, and assume definite shapes according to the species. Of this character are the fructifying organs which constitute the above ground parts of Puff Balls, Morels, Ergot, Cup Fungi, Mushrooms, etc. There are four sub-classes of True Fungi, viz.: Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes or Fungi Imperfecti.

Of these only the Ascomycetes and Basidiomycetes yield official drugs.

#### SUB-CLASS—ASCOMYCETES OR SAC FUNGI

This is the largest group of true fungi, containing thousands of species which vary from unicellular organisms such as the yeasts to multicellular forms like *Penicillium*, *Aspergillus*, *Claviceps*, *Peziza*, etc. In all, the life history is characterized by the appearance of a sac called an *ascus* in which *ascospores* are formed. The mycelium is composed of septated filaments (*hyphæ*).

#### SACCHAROMYCETACEÆ OR YEAST FAMILY

Unicellular plants of spheroidal, oval, ellipsoidal or pyriform shape, in whose life history a mycelium is wanting. They occur either in the wild or cultivated condition and are of considerable economic value on account of their ability to break down some form of carbohydrate substance into carbon dioxide and alcohol. Reproduction is by gemmation (budding) and through the formation of ascospores.

#### DRIED YEAST U.S.P. (SACCHAROMYCES SICCUM)

**Synonyms.**—*Dry Yeast*, *Dried Leaven*, *Fæx Medicinalis*; *Ger.* Hefe; *Fr.* Levure.

**Botanical Origin.**—*Saccharomyces cerevisiæ* Meyen.

**Part Used.**—The dry cells of any suitable strain of yeast.

**Standard of Assay.**—Not less than 40 per cent of protein and, in each Gm., the equivalent of not less than 0.12 mg. of thiamine hydrochloride, 0.04 mg. of riboflavin, and 0.25 mg. of nicotinic acid.

**Limit of Impurities.**—Not more than 7 per cent of moisture, not more than 8 per cent of ash, not more than 7500 live bacteria per Gm. and not more than 50 molds per Gm.

**Plant.**—*Saccharomyces cerevisiæ*, commonly called Brewer's Yeast, is a cultivated species with many strains. It is used extensively in the brewing and baking industries. When examined under the microscope it is somewhat spheroidal to ellipsoidal in outline, 8 to 12 $\mu$  long, and 8 to 10 $\mu$  broad. It consists of an outer cell wall of *fungous cellulose* enclosing cytoplasm and a nucleus, the latter invisible without special staining. The cytoplasm is differentiated into a clear outer membrane lying directly within the cell wall and termed the *ectoplasm* and an inner granular region, the *endoplasm*. In the young condition of the yeast cell numerous glycogen vacuoles are found scattered more or less uniformly

throughout this region, but, as the cell matures, these coalesce, until, in a very old cell, a huge glycogen vacuole may be seen occupying most of the interior, with the cytoplasm and nucleus pushed up against the cell wall and forming there a very narrow layer.

Yeast plants are saprophytes. They grow in and obtain their nutrition from dilute saccharine solutions containing dissolved nitrogenous substances such as beerwort, Pasteur's solution, grape juice, etc.

Yeast causes a wholesale destruction of sugar in sugar solutions. The fermentative ability of the plant is due to two enzymes, *invertase* and *zymase*. *Invertase*, an extracellular enzyme, diffuses out of the cell into the solution in which the yeast is growing and hydrolyzes cane sugar into dextrose and levulose;

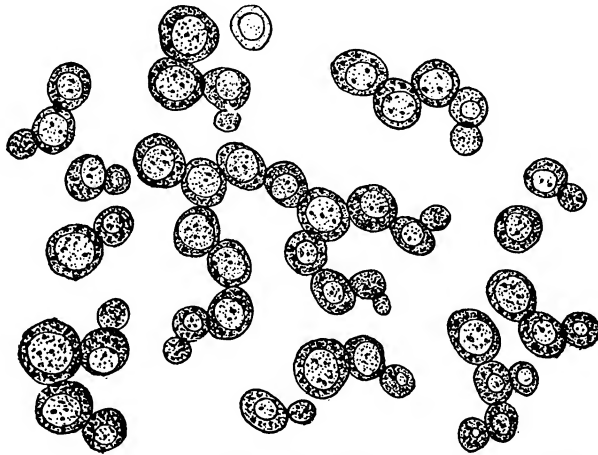


FIG. 15.—Yeast (*Saccharomyces cerevisia*). (After Schneider.)

*Zymase*, an endocellular ferment, remains within the cell, being incapable of osmosis, and there ferments the dextrose and levulose to form carbon dioxide and alcohol. The alcohol of commerce is produced by the activity of this plant.

The vegetative method of reproduction in *Saccharomyces* is that of *gemmation* or *budding*. A small protuberance of the cell wall commences to form on the parent-cell. This grows larger and a portion of the cytoplasm and nuclear material pass into it. Eventually a daughter-bud, which may assume the size of the parent-cell, is formed. This generally adheres to the parent-cell and produces one or more granddaughter-buds which in turn may produce great-granddaughter-buds before separation from the parent-cell takes place. Yeast also reproduces by ascospore formation.

There are two well-known varieties of brewer's yeast, viz.: Top yeasts and Bottom yeasts. Top yeasts grow on or near the surface of the liquid and produce rapid fermentation at summer temperatures, causing great quantities of carbon dioxide to arise to the surface and thus forming the froth which is characteristic of ale, stout and porter.

Bottom yeasts grow slowly at about 4°C. at or near the bottom of the vat. They are used in the manufacture of Lager beers.

**Production.**—Dried yeast is either obtained as a by-product from the brewing of beer made by fermenting an extract of cereal grains and hops with a strain of living yeast and subsequently washing the yeast cells from the vat to remove the beer and drying (*Brewer's Dried Yeast*) and debittering (*Debittered Brewer's Dried Yeast*) or (2) by culturing suitable strains of yeast on other kinds of nutrient media, washing and drying (*Primary Dried Yeast*). If labeled, it must show its appropriate source. It must contain not more than 7 per cent of moisture.

**Description.**—It occurs as yellowish white to weak yellowish orange flakes, powder or granules with an odor and taste characteristic of the type and is incapable of inducing fermentation.

**Histology.**—In water mounts it shows yeast cells both isolated and in masses, the isolated cells ovate, elliptical, spheroidal or elliptic elongate in shape, some with one or more attached buds; up to 12 $\mu$  in length and up to 7.5 $\mu$  in width; each with a wall of fungous cellulose surrounding a protoplast containing refractile glycogen vacuoles and oil globules; occasional segments of elongated forms of yeast films and septated hyphal outgrowths of *Saccharomyces cerevisia*.

**Constituents.**—The Vitamin B Complex including the water-soluble *vitamins B<sub>1</sub>*, *B<sub>2</sub>* and *B<sub>6</sub>* or *Pyridoxine*, *Nicotinic Acid* and *Pantothenic Acid*; fat, ergosterol, nucleins, nucleoproteins and carbohydrates. *Vitamin B<sub>1</sub>* or Thiamine Hydrochloride is the antineuritic factor. It occurs in the germs and bran of cereals, in egg yolk, milk, in leguminous seeds, nuts, etc. Deficiency of this vitamin in the diet causes the disease in man known as beri-beri, and polyneuritis in animals. *Vitamin B<sub>2</sub>* also called *Vitamin G* or *Riboflavin* is the pellagra preventive factor. It also occurs in egg white, green vegetables, leguminous seeds, nuts, cereals, etc.

**Uses.**—Apart from its use in the brewing industry, living yeast is used to raise dough and in the preparation of Kumyss. It is employed medicinally as a laxative and in the treatment of boils, unhealthy wounds and various skin eruptions. *Dried yeast* is used internally in the treatment of pellagra and neuritis. A number of trade brands of yeast tablets and yeast extracts containing the Vitamin B Complex occur on the market. Yeast is a source of ergosterol.

**Average Dose.**—To be determined by the physician in accordance with the needs of the patient.

**Preparation.**—Dried Yeast Tablets, U.S.P.

**Ergosterol.**—Ergosterol is an unsaturated sterol (C<sub>27</sub>H<sub>41</sub>OH) isolated from ergot in 1908 by Tanret and since prepared by the saponification of yeast with caustic soda solution. When exposed to short wave radiations (ultraviolet radiations) from sunlight or from a quartz-mercury vapor lamp, ergosterol is changed to a yellowish gummy substance called *irradiated ergosterol* from which *Vitamin D* has been isolated in crystalline form by Bourdillon. Both irradiated ergosterol and vitamin D have marked anti-rachitic properties when administered in minute doses. Activated Ergosterol is Vitamin D<sub>2</sub>.

**Viosterol** is a name given by the Council of Pharmacy and Chemistry of the A.M.A. to forms of activated ergosterol and irradiated ergosterol. Viosterol

in Oil is prepared either (1) by the activation of purified ergosterol by low velocity electrons, separating the activated ergosterol and dissolving it in a vegetable oil or (2) by the irradiation of a solution of purified ergosterol by ultraviolet rays under reflux in an inert atmosphere, removing the unchanged ergosterol, distilling the remaining solvent and dissolving the irradiated ergosterol in a vegetable oil.

**Synthetic Oleovitamin D (Oleovitamina D Synthetica)** U.S.P.—*Viosterol in Oil*.—A solution of activated ergosterol, or activated 7-dehydro-cholesterol in a vegetable oil and standardized so as to contain the equivalent of at least 10,000 U.S.P. units of vitamin D in each Gm. It must be labeled to indicate whether it contains activated ergosterol (Vitamin D<sub>2</sub> or Viosterol) or whether it contains activated 7-dehydro-cholesterol (Vitamin D<sub>3</sub>). It is used in the treatment of abnormal calcium and phosphorus metabolism. **Dose:** For average infant, 0.1 cc. or  $\frac{2}{3}$  minim; for premature and rapidly growing infants, 5 minims; daily curative dose, 5 to 7 minims.

#### HYPOCREACEÆ FAMILY

This family includes about 57 genera of parasites found on fungi, grasses and cereals, trees and insects. It is characterized by the perithecia being more or less spherical and opening by means of an apical pore. Arising from the base of each perithecium are to be noted a cluster of eight-spored asci.

#### ERGOT N.F. (ERGOTA)

**Synonyms.**—*Rye Ergot*, Ergot of Rye, Spurred Rye, *Secale cornutum* P.I. Horn-seed; *Ger.* Mutterkorn; *Fr.* Ergot de Seigle.

**Botanical Origin.**—*Claviceps purpurea* (Fries) Tulasne.

**Part Used.**—The dried sclerotium, developed on rye (*Secale cereale*) plants.

**Limit of Impurities.**—4 per cent. of seeds, fruits, or other foreign organic matter; 8 per cent. of moisture.

**Habitat.**—Russia, Spain, Portugal and other eastern countries, infesting the ovaries of various cereals and grasses.

**Plants.**—Two plants are concerned in the formation of Ergot, namely, *Secale cereale*, the common rye, which is the host and *Claviceps purpurea*, the parasite. *Secale cereale*, is an annual member of the grass family. Its underground portion consists of a whorl of four primary roots which branch profusely. Its aerial portion consists of a tough, slender 4-7 (usually 5-6) jointed stem, 1.5-2 m. high, which bears alternate, 2-ranked grass-like leaves. The inflorescence is a 4-rowed spike with 20-30 rachis joints, each joint bearing a spikelet. Each spikelet consists of three flowers, the two lateral ones alone maturing grains. The glumes are narrow and bristle-like. The fruit is a long narrow grain.

The parasitic fungus, *Claviceps purpurea*, is very prevalent in grain fields both in this country and Europe during moist warm weather. Through the agency of winds or insects (ants, flies, or beetles), its spores (ascospores or conidia) are brought to the young ovaries of the rye. At the base of the ovary, where,



during damp weather moisture is abundantly present, they germinate into hyphal filaments which secrete a ferment and so penetrate the basal portion of the ovary. From here the hyphal strands extend superficially over the



FIG. 16.—A, *Balansia claviceps* on ear of *Paspalum*; B–L, *Claviceps purpurea*; C, sclerotium with *Sphacelia*; D, cross-section of sphacelial layer; E, sprouting sclerotium; F, stalked ascocarp (*stroma*) from sclerotium; G, section of same; H, section of perithecium; J, ascus; K, germinating ascospore; L, conidiospores produced on mycelium. (See *Die natürlichen Pflanzenfamilien* I, 1, p. 371.)

ovarian substance forming a mycelium, and the ferments secreted cause decomposition of the tissue with the resultant formation of a yellow-mucus substance called honey dew. The ovary enlarges and its upper end presents a spongy

appearance. This is due to the outcropping of the mycelium in the form of twisted strands. The hyphæ, here, abstrict off chains of conidiospores, which become imbedded in the honey dew. The honey dew attracts certain insects which disseminate the disease to other spikes of grain. This ends what is termed the *sphacelia* stage.

The mycelial threads penetrate deeper and deeper into the ovary and soon form a dense tissue which gradually consumes the entire substance of the ovary and hardens into a purple, somewhat curved body called a *sclerotium*, or official ergot—the resting stage of the fungus, *Claviceps*.

The ergot falls to the ground and in the following spring sprouts into several long-stalked, globular heads called *stromata* or *ascocarps*. Each (fruiting) head or ascocarp has imbedded in its surface numerous flask-shaped invaginations called *perithecia*, from the bases of which several sacs or *asci* develop. Within each ascus are developed eight filiform spores (*ascospores*) which, when the ascus ruptures, are discharged and are carried by the wind to other fields of grain, there to begin over a new life cycle.

**Production and Commerce.**—Ergot has been gathered chiefly in Spain, Poland, Russia, Germany, Galicia and Austria, being usually separated from the rye after it has been thrashed by special machinery, although also picked by hand. It is dried at a low temperature. The supplies imported into the United States in 1940 came from Portugal, Spain, Belgium, Hungary, Rumania and the United Kingdom in drums. During 1946 this country imported 400,300 pounds of ergot. Ergot of domestic rye is now being produced on an increasing commercial scale in Minnesota and neighboring states. It differs chiefly from foreign rye ergot in the relative size of the cell forms and in yielding a higher percentage of alkaloids (0.306 to 0.380 per cent, as ergotoxine). The N.F. requires ergot to be stored under all conditions of storage and transportation in a dry place. Ergot deteriorates rapidly if not properly dried before shipment, or exposed to

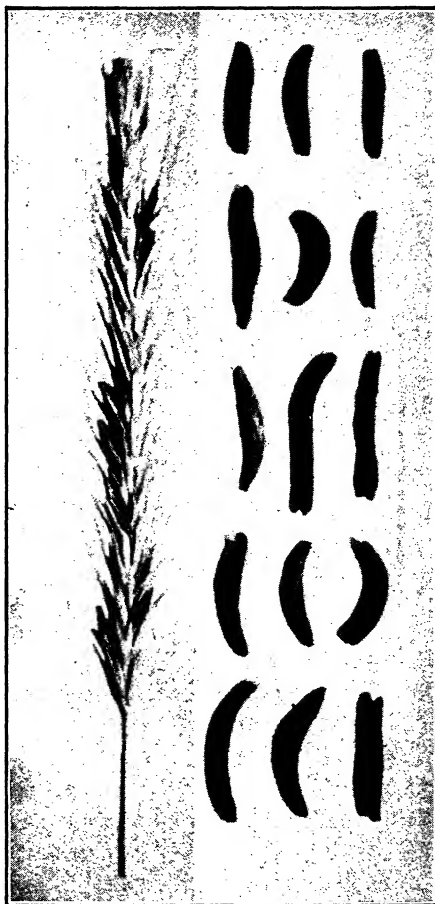


FIG. 17.—Ergot. On left, a spike of rye showing a number of blackish objects which represent grains transformed into ergot sclerotia. On right, Ergot,  $\times 36$ .

moisture subsequently. If not dried thoroughly before being placed in containers or if placed in these in rooms containing a humid atmosphere, or if the container is later opened for the removal of some of its contents in the presence of a moisture-laden atmosphere, it would be impossible to control the limit of moisture unless some desiccating agent in sufficient amount were placed in the can or drum containing the ergot. Accordingly, it is suggested that a suitable cartridge containing a nonliquefying, inert, dehydrating substance like silica gel or drierite be inserted in the container to maintain low humidity.

**Description.**—The sclerotium is somewhat cylinder-like, obscurely 3-angled, tapering toward both ends, obtuse, somewhat curved, from 0.7 to 4.5 cm. in length and up to 5 mm. (European Ergot) or up to 7 mm. (Domestic Ergot) in thickness; externally nearly black or purplish brown, longitudinally furrowed, occasionally transversely fissured; fracture short; internally white or grayish-white, relatively few sclerotia being tinged with pink or lavender; odor peculiar, disagreeable, free from mustiness and rancidity; taste oily and disagreeable. No ammoniacal or rancid odor should develop when hot water is poured on crushed or powdered Ergot (*purity test*).

**Histology.**—Transverse sections exhibit under the microscope a thin outer zone of small compact hyphal cells of a purplish or violet color, turning red with 50 per cent.  $\text{H}_2\text{SO}_4$  or with chloral hydrate solution and a broad inner zone of pseudoparenchyma composed of colorless, thin-walled hyphal cells, each usually less than  $20\mu$  in width, occasionally up to  $28\mu$  in width, slightly elongated in longitudinal sections and containing globules of fixed oil and protein granules.

**Powdered Drug.**—Grayish to purplish brown. It shows for the most part whitish fragments composed of false parenchyma (compacted hyphæ) and some purplish fragments of the outer region of the sclerotium. Upon mounting a small portion in chloral hydrate T.S. or in 50 per cent. sulfuric acid, numerous globules of fixed oil separate and many of the fragments are colored yellow, red, or rose-purple.

**Identity Test.**—Place 1 Gm. of ergot, 20 cc. of ether and 15 drops of 20 per cent.  $\text{H}_2\text{SO}_4$  in a flask, stopper, and shake for 5 minutes. Filter, and shake the filtrate thoroughly with 15 drops of cold, saturated solution of sodium bicarbonate. The separated lower, aqueous layer is red or violet (*sclererythrin*).

**Constituents.**—Ergonovine, the chief oxytocic principle, also known as *ergostetrine* (Thompson), *ergometrine* (Dudley and Moir) and *ergotocin* (Kharasch and Legault); *ergotoxine*,  $\text{C}_{35}\text{H}_{41}\text{O}_6\text{N}_5$  (an amorphous alkaloid yielding crystalline salts and quite soluble in cold alcohol, sparingly in ether), *ergotamine*,  $\text{C}_{33}\text{H}_{35}\text{O}_6\text{N}_5$  (a crystalline alkaloid), *ergotinine*,  $\text{C}_{35}\text{H}_{39}\text{O}_6\text{N}_5$  (a crystalline alkaloid sparingly soluble in cold alcohol), *histamine*, a pressor principle called *tyramine*; acetylcholine, sclererythrin (coloring principle), etc.

Spanish rye ergot averages, according to Hampshire and Page, 0.208 per cent. and Russian rye ergot, 0.0615 per cent. total alkaloid, as ergotoxine.

**Uses.**—Emmenagogue, parturient, hemostatic, ecboic, motor excitant. As a parturient (in labor) and hemostatic (in uterine hemorrhage), to check

menorrhagia and metrorrhagia, to overcome subinvolution or atony of the uterus and vascular disturbances of menopause, etc.

**Average Dose** (unof.).—2 Gm. (30 grains).

**Preparations.**—Ergot Extract, N.F., 0.5 Gm. ( $7\frac{1}{2}$  gr.); Ergot Fluidextract, N.F., 2 cc. (30 minims); Prepared Ergot (Powdered Defatted Ergot), N.F., 1.5 Gm. (22 grains); Ergot Aseptic, N.N.R. (in ampules for intramuscular injection) 1 to 2 cc. (15 to 30 minims).

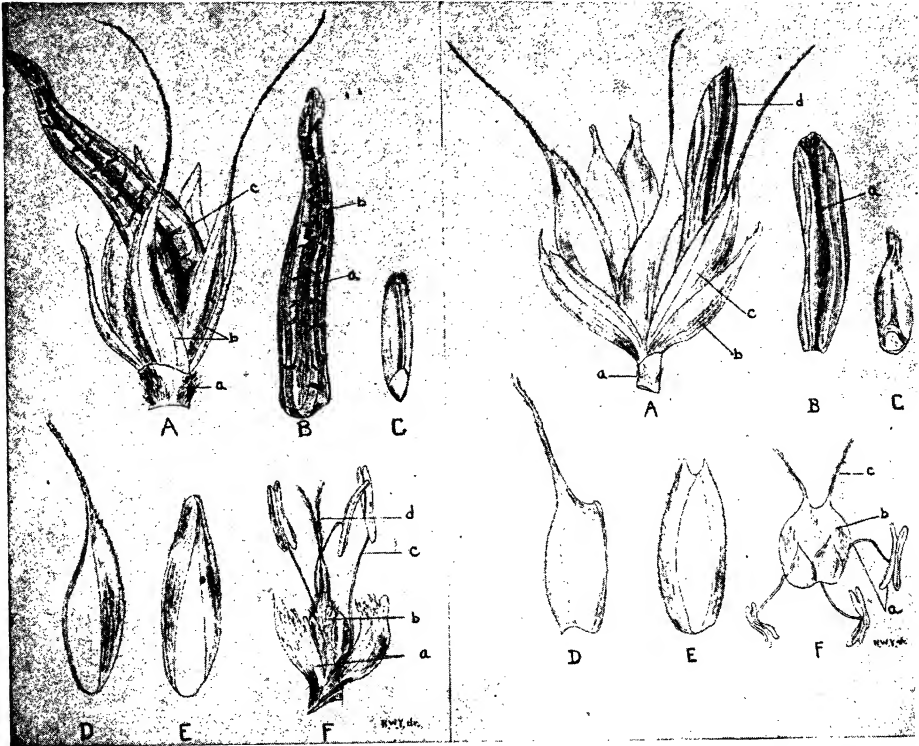


FIG. 18 (Left).—Ergot developing in spikelet of domestic rye, *Secale cereale*. A, spikelet: a, rachilla; b, glumes; c, ergot sclerotium; B, ergot sclerotium: a, longitudinal furrow; b, transverse fissure; C, rye caryopsis; D, glume; E, lemma; F, flower: a, lodicules; b, ovary; c, stamen; d, style.

(Right).—Ergot developing in spikelet of domestic durum wheat, *Triticum durum*. A, spikelet: a, rachilla; b, c, glumes; d, ergot sclerotium; B, durum wheat ergot sclerotium: a, longitudinal furrow; C, wheat caryopsis; D, glume; E, lemma; F, flower: a, stamen; b, ovary; c, style and stigma. (After H. W. Youngken, Jr. in *Economic Botany*, 1 (1947), 375.)

**Ergonovine Maleate** (Ergonovinæ Maleas) U.S.P.—The maleate of an alkaloid obtained from ergot  $C_{19}H_{23}N_3O_2 \cdot C_4H_4O_4$ . It occurs as a white or faintly yellow, odorless, microcrystalline powder and is soluble in about 36 parts of water, the solution possessing a blue fluorescence. It is used as a prompt ebolic in labor but the duration of its effect is less prolonged than ergotoxine. Average dose, intravenous or intramuscular, 0.2 mg. ( $\frac{1}{300}$  gr.), oral, 0.5 mg. ( $\frac{1}{120}$  gr.).

**U.S.P. Preparations.**—Ergonovine Maleate Injection, Ergonovine Maleate Tablets.

**Ergotamine Tartrate** (Ergotaminæ Tartras) U.S.P.—The tartrate of an alkaloid obtained from ergot.  $(C_{33}H_{35}N_5O_5)_2 \cdot H_2C_4H_4O_6$ . It occurs as colorless crystals or as a white crystalline powder, one Gm. dissolving in 500 cc. of water. It is used as a stimulant to the uterus during labor and in the treatment of uterine hemorrhages. Average dose, intramuscular, 0.5 mg. ( $\frac{1}{20}$  gr.), oral, 1 mg. ( $\frac{1}{60}$  gr.).

**Preparation.**—Ergotamine Tartrate Tablets U.S.P.

**Prepared Ergot N.F.** (Ergota Præparata).—*Powdered Defatted Ergot.*—This is the most stable and suitable form of whole ergot for oral internal administration. It represents ergot which has been powdered and immediately deprived of most of its fat by percolation with petroleum benzin. It contains not more than 6 per cent of moisture. It must be stored in tight containers in a cool place. Av. dose, 1.5 Gm. (22 grains).

**Histamine Phosphate** U.S.P. (Histaminæ Phosphas) is a phosphate of  $\beta$ -iminazolyethylamine. It occurs in colorless, odorless, long prismatic crystals and is soluble in about 4 parts of water. Used for testing the stomach in order to distinguish true gastric achylia from the pseudo-type, in doses of 0.5 to 1 mg. injected subcutaneously or intramuscularly; also in pruritis, tinnitus, and arthritis. Average dose, intramuscular, 0.3 mg. ( $\frac{1}{200}$  grain).

**Preparation.**—Histamine Phosphate Injection, U.S.P., given by intramuscular injection.

**Allied Ergots.**—(1) Domestic Ergot of Durum Wheat. This develops on *Triticum durum* Desf. It possesses straight to slightly curved, cylindrical to ovate sclerotia, 6 to 15 mm. in length and from 2 mm. to occasionally more than 5 mm. in width, the end region being usually blunt and rounded; externally purple to purplish black, longitudinally furrowed, with short longitudinal fissures and with less conspicuous transverse fissures than rye ergot; inner surface whitish to pinkish-white, fracture sharp and waxy; taste oily. It was found to contain from 0.044 to 0.066 per cent. of total alkaloids, as ergotoxine.

(2) Ergot of Domestic Durum Wheat, Striated possesses sclerotia which are straight or rarely slightly curved, cylindrical, lanceolate, 6.5 to over 15 mm. in length and 2 to 5 mm. in thickness, both extremities ending in blunt, obtuse points; externally marked by numerous longitudinal shallow furrows and with striations of purplish black and varying tints of rose and with infrequent transverse fissures; fracture hard, short and waxy; internally white to pinkish white; taste oily and somewhat acrid. It contains an average of 0.072 per cent. of total alkaloid calculated as ergotoxine.

(3) Domestic Hybrid Wheat Ergot (*Triticum durum* Desf.  $\times$  *Elymus condensatus* Presl., the giant wild rye) consists of lanceolate to linear-lanceolate sclerotia, mostly straight with tapered ends; externally purplish to purplish-brown, longitudinally furrowed and transversely fissured; fracture short, the fractured surface pinkish-white to nearly white with narrow stellate markings emanating from the center; odor characteristically sweet; taste pungent and

oily. It was found to contain 0.105 to 0.115 per cent. of total alkaloid, as ergotoxine. For additional details on domestic ergots, see Youngken, Jr., Fischer and Rogers, J. A. Ph. A. Sci. ed. 31 (1942), 136.

(4) Ergot of Diss is developed on a tall Algerian reed, *Ampelodesma tenax* (Fam. *Gramineæ*). It is thinner and longer than the preceding ergots, being up to 9 cm. in length, frequently spirally twisted and longitudinally furrowed on its inner side.

#### SUB-CLASS—BASIDIOMYCETES (BASIDIA FUNGI)

A large group of fungi characterized by the occurrence of a basidium in its life history and the presence of septated hyphæ. It includes the smuts, rusts, the mushrooms and toadstools, pore fungi, weeping fungi, puff-balls, earth stars, nest fungi, carrion fungi, etc.

#### POLYPORACEÆ (PORE FUNGI) FAMILY

The sporophores or fruiting bodies of these fungi are various. They may be entirely supinate with pores or shallow depressions on their upper surfaces (*Merulius*), or mushroom-like (*Boletus*), or of the nature of woody (*Polyporus*, *Lenzites* and *Fomes*) or fleshy (*Fistulina*) brackets. In all cases the hymenium or basidial layer lines the inner surface of pores. Belonging to this family are a number of economically important fungi, many of which are destructive to timber, to wood exposed to the weather and to living trees.

#### AGARICUS (AGARIC)

**Synonyms.**—Larch Agaric, White Agaric; *Fr.* Polypore du Mêleze; *Ger.* Larchenschwamm.

**Botanical Origin.**—*Polyporus officinalis* Fries.

**Part Used.**—The dried fruit body, deprived of its outer rind.

**Habitat.**—On species of *Pinus*, *Larix* and *Picea* (Pines, Larches and Spruces) of the eastern and western hemispheres.

**Description.**—This drug is found as irregular, light, fibrous and somewhat spongy pieces of the sporophore; externally grayish-white to pale brown; internally pale yellow and resinous; fracture tough, fibrous; odor indistinct; taste sweet, acrid and bitter.

**Constituents.**—*Agaric acid*, resin, tannin, phosphoric acid, tartaric acid, oxalic acid, malic acid, fat, protein, etc. Agaric acid, the chief active principle, occurs in yellowish crystals. Preparations of agaric acid occur on the market under the name of *agaricin*.

**Use.**—Larch agaric has been used as an anhydrotic in sweats of wasting diseases as pulmonary tuberculosis. The active principle, agaricin, has now largely replaced it in therapy.

**Average Dose.**—0.6 Gm. (10 grains), of agaric acid (*agaricin*) 10 to 30 mg., ( $\frac{1}{6}$  to  $\frac{1}{2}$  gr.).

**Allied Plant.**—*Polyporus fomentarius* (L.) Fries or Surgeon's Agaric, found on the oaks and beeches of Europe, has been used as a styptic in external hemorrhages.

## AGARICACEÆ (GILL FUNGI) FAMILY

The largest and most widely distributed of all the families of fungi, containing more than 5000 described species of edible, emetic, and poisonous fungi called mushrooms and toadstools. Their vegetative body consists of a mycelium composed of septated filaments or hyphæ which ramify through the substratum which may be the soil, leaf mould, manure, decayed timber, old stumps, living trees, etc. Their fruit bodies (sporophores) are mostly fleshy and umbrella-like in form. These usually consist of a stalk or stipe and a pileus or cap, but the stalk may be absent. Gills or lamellæ are attached to the lower surface of the pileus in radiating fashion. They are lined with a hymenium consisting of a layer of basidia, each of which usually bears four, sometimes three or two basidiospores. The color of the spores is distinctive and is used in classifying the genera of the family. Thus, there are white-spored, rosy-spored, yellow-spored, brown-spored, green-spored and black-spored agarics.

Many cases of poisoning by gill and other fungi occur annually and pharmacists are often called upon to identify the species responsible. Some of the more common edible and poisonous forms are discussed here. For further information, the reader is referred to special works on the subject, such as "*One Thousand American Fungi*" by Charles McIlvaine, "*Mushrooms and Toadstools*" by H. T. Güssow and W. S. Odell, etc.

*Agaricus campestris* (*Psalliota campestris*), the Common Mushroom, is an edible species which grows in open grassy fields in both hemispheres. It represents the species which is most abundantly cultivated for the table. Its pileus is convex, nearly flat, when expanded, smooth, silky-floccose or scaly, white or light brown, the margin incurved, the flesh white and firm. Its gills are free from the stipe, white in the button stage, pink in the young stages but later becoming purplish brown, dark brown or nearly black. The stipe is white, smooth or nearly so and possesses a frail ring or annulus which sometimes disappears as the mushroom attains maturity.

*Agaricus arvensis*, the horse- or field-mushroom, occurs in fields, pastures and waste places. It differs from the common mushroom in being larger at maturity and in possessing a double annulus, the upper part of which is white and thick, the lower yellowish and split.

All species of *Agaricus* are edible.

*Coprinus comatus*, the Shaggy Mane, is of wide distribution on lawns, ash heaps, in gardens, etc. where it occurs singly or in clusters. It and other species of *Coprinus* are edible. They are readily identified by their black spores and dense gills which at maturity form an inky fluid. Its cap is oblong, bell-shaped, 2 to 4 in. in length, moist and fleshy, with a cuticle that separates into scales, beneath which the flesh is white. Its gills are free, crowded, at first white, early becoming pink and later purplish black. Its stipe is hollow, brittle, slightly bulbous at the base and readily separable from the cap. Its annulus is thin and movable. If eaten when too mature, it possesses irritant properties.

*Amanita muscaria*, the Fly Agaric, is a very poisonous species responsible for many deaths and serious illnesses. It occurs during summer and autumn in cultivated soil, in woods and along roadsides, either singly or in groups. Its pileus is 3 to 6 in. broad, globose, convex and later flattened, possesses a white flesh, sometimes yellow under the cuticle, the upper surface varying in color from blood red to orange red to yellow and covered with floccose scales. Its gills are white to faintly yellow and free. Its stipe is at first stuffed, later hollow, the upper part with a large, ragged, soft white annulus, the base with a prominent white to yellowish volva which is marked by concentric ridges. Its chief poisonous constituent is *muscarine*. Treatment for poisoning by this fungus consists in giving a strong emetic followed by hypodermic injections of atropine, beginning with  $\frac{1}{60}$  of a grain.

*Amanita phalloides*, the Death Cup or Destroying Angel, is of common occurrence in woods, along borders of woods, and in cultivated land during summer and autumn. Its pileus is commonly white, but varies in varieties and forms from lemon yellow to dull green, olive gray and greenish brown, is smooth or with few patches, ovate, becoming later convex. Its gills are free and white. Its stipe is generally free and white, or in varieties colored like the cap, stuffed or hollow, tapering toward the cap and bulbous at the base. The volva is partially buried in the soil, white and fleshy.

Its chief poisonous constituents are the glucoside, *amanitahemolysin*, a blood-laking principle, and the toxin called *amanita-toxin*. The majority of cases of poisoning by this toadstool have been fatal. Treatment consists in emptying the stomach and intestine as promptly as possible by means of an emetic of mustard water and an enema of luke-warm soapy water and giving the patient plenty of lukewarm water to drink. In all cases of toadstool poisoning, the physician should be promptly summoned.

*Clitocybe illudens* known as Jack-my-lantern, another poisonous form, grows in large patches at the base of decayed stumps in autumn. The whole plant is of a saffron yellow color. Its pileus is 3 to 5 in. wide, with a soft white to yellow flesh, convex at first with an elevation in the center, becoming depressed in the center with age. The gills are decurrent along the stem for some distance. The stipe is solid, smooth, and tapers toward the base. Like other species of *Clitocybe* it is devoid of annulus and volva.

#### SUBDIVISION—LICHENS

Lichens are variously colored, usually dry leathery plants, consisting of symbioses of algæ and fungi. Blue-green and Protococcus forms of Green Algæ and Ascomycete Fungi represent the main forms concerned in lichen formation. The body of a lichen, when examined microscopically, shows differentiation into 2 regions: (1) a more or less compact row of cells on both surfaces called the epidermis and (2) an inner portion composed of fungal hyphæ in close association with algal cells. Lichens reproduce by spores which are borne in asci. The latter are borne in 'fruiting bodies called apothecia and pycnidia. Many of the lichens, like *Cetraria islandica* or *Iceland Moss*, have been valued because of



their demulcent properties while others, as species of *Roccella* and *Lecanora*, yield upon fermentation valuable coloring principles.

#### PARMELIACEÆ (PARMELIA FAMILY)

##### CUDBEAR N.F. (PERSIO)

**Synonyms.**—Red Indigo; *Fr.* Orseille de terre; *Ger.* Rothe Indigo.

**Botanical Origin.**—Species of *Roccella* DC., *Lecanora* Ach. and other lichens.

**Part Used.**—A powder.

**Purity Rubric.**—Not more than 12 per cent. of total ash.

**Habitat.**—Eastern and Western Hemispheres.

**Production and Commerce.**—The lichens used in the preparation of cudbear belong to several genera. Chief among those identified are *Roccella tinctoria* Ach. or Orchilla Weed, from the Mediterranean coasts, Canary and Cape Verde Islands, *Lecanora tartarea* Ach. or Tartarean Moss from Northern Europe, *Roccella Montagnei* Bel. from Mozambique and Madagascar and *Dendrographa leucophæa* Darb. from California. The substances or mother principles in these plants which yield cudbear are themselves colorless and are said to be acids or acid anhydrides as lecanoric acid, orsellic acid, etc. These upon oxidation in the presence of ammonia split first into orcin (colorless) and are then converted into orcein and other colored substances. The lichens are gathered from rocks, cleaned, dried and ground. They are then macerated in an ammoniacal liquid of urine, lime, and potash or soda for nearly a week during which time a purplish-red color develops. The resultant paste is dried and reduced to a powder. The chief sources of production at present are the Canary Islands, Madagascar and the coast of Africa.

**Description.**—A very dusky red-purple to very dusky red powder which imparts to aqueous or alcoholic preparations a deep red color. This color is rendered lighter in tint by the addition of acids, and is changed to purplish red by the addition of alkalis. When examined under the microscope it shows fragments of hyphæ from the subhymenial layer of the lichen and fragments of pseudoparenchyma. Woody and leafy tissue is permissible only in limited amounts.

**Constituents.**—*Erythrolitmin*, a deep red crystalline substance, and *azolitmin*, a brownish-red coloring principle.

**Uses.**—Coloring agent for various pharmaceutical preparations and as a dye in the arts.

**Adulterants.**—Ground wood of dicotyledons and conifers, ground logwood, potato starch, corn starch, sodium chloride, arsenic, coal-tar colors.

**Preparations.**—In N.F.: Cudbear Tincture, Compound Cudbear Tincture (from Tr.).

**Allied Drugs.**—Orchil or Archil is a coloring substance obtained by the fermentation of *Roccella tinctoria*, *R. fuciformis* and other lichens. It contains *orcein* which dissolves in alcohol and water producing scarlet-red solutions and in alkaline solutions, imparting a lavender to purple color.\* Coloring agent.

**Litmus** or Lacmus represents a dried extract obtained from *Lecanora tartarea*

and other lichens which yield orcinol. The lichens are ground, mixed with potassium carbonate, water and an ammoniacal liquid and allowed to ferment for several weeks. During fermentation the mother principle called *lecanoric acid* which is colorless changes to orcinol and then to *erythrolitmin* and *azolitmin*. The latter imparts a blue color to the solution. The solution is then mixed with powdered chalk, moulded into rectangular cakes and dried. Litmus is manufactured in Holland. It is used as an indicator of acidity and alkalinity in the form of litmus paper or in solution, these turning blue with alkalies and red with acids.



FIG. 19.—*Cetraria islandica*, a lichen known as Iceland Moss which has been used as a nutrient and demulcent. (Sayre.)

**Cetraria** or Iceland Moss consists of the dried plant of *Cetraria islandica* Acharius (Fam. *Parmeliaceæ*), a foliaceous lichen collected in Iceland and Europe. It contains *lichenin* (soluble in hot water), *isolichenin* (partly soluble in cold water), a green coloring substance called thallochlor, proto-a-lichesteric acid, *gum*, oxalic, lichenic and tartaric acid, etc. It is used by the laity in the form of Iceland moss jelly and in decoction as a nutrient and demulcent.

## DIVISION II.—BRYOPHYTA (BRYOPHYTES)

Plants showing a beginning of definite alternation of generations, *i.e.*, gametophyte (sexual phase) alternating with sporophyte (asexual phase of development) in their life history, the two phases being combined in one plant. The female sexual cell is always lodged in an *archegonium* (a multicellular female sexual organ).

### SPHAGNUM

**Synonyms.**—Peat Moss, Bog Moss.

**Botanical Origin.**—*Sphagnum imbricatum*, *S. palustre*, *S. papillosum*, *S. magellanicum* and probably other species of *Sphagnum*.

**Part Used.**—The entire plant.

**Habitat.**—In bogs of the eastern and western hemispheres.

**Histology.**—Under the microscope, sphagnum leaves show broad areas of colorless, porous cells with oblique septa, capable of absorbing and holding quantities of liquid. It is these cells which give sponginess to even partially dried and dead specimens. Elongated and slender chlorophylloid cells are present surrounding the colorless cell areas.

**Uses.**—Sphagnum has proven a more excellent absorbent than cotton and as such has been employed in surgery in the form of pads. It is now used in the manufacture of some sanitary napkins. Its saturation time is but  $\frac{1}{3}$  to  $\frac{1}{2}$  that of absorbent cotton and it possesses the additional advantages of being antiseptic because of its iodine content, and less expensive.

### DIVISION III.—PTERIDOPHYTA (PTERIDOPHYTES)

This division includes the club mosses, scouring rushes and ferns. All of these show a distinct alternation of generations in their life history. The sporophyte is characterized by separating very early from the gametophyte (prothallus) and living thereafter an independent existence. It is furthermore leafy, vascular and root bearing.

#### SUBDIVISION—LYCOPODINEÆ OR CLUB MOSSES

Small, perennial, vascular, dichotomously branched herbs with stems thickly covered with awl-shaped leaves. The earliest forms of vascular plants, differing from ferns in being comparatively simple in structure, of small size, leaves sessile and usually possessing a single vein. Except in a few instances the sporangia are borne on leaves, crowded together and forming cones or spikes at the ends of the branches—homosporous (spores of one kind).

#### LYCOPODIACEÆ (CLUB MOSS FAMILY)

A family of trailing or upright, moss-like herbs with many small, usually subulate or lanceolate leaves and elongated stems. The prothallus is subterranean.

#### LYCOPodium N.F. (LYCOPodium)

**Synonyms.**—Vegetable Sulfur, Common Club Moss, Wolf's Claws, Lamb's or Fox Tail; *Fr.* Saufre végétale; *Ger.* Streupulver, Bärlappsamen.

**Botanical Origin.**—*Lycopodium clavatum* Linné.

**Part Used.**—The spores.

**Purity Rubric.**—Not more than 0.75 per cent. of acid-insoluble ash.

**Plant.**—A creeping, prostrate, horizontally branching, perennial club moss. From the main prostrate stems arise aerial stems. The leaves are crowded, many ranked, linear-awl-shaped and bristle tipped. The peduncles are stout, often forked near the summit, with slender bristle-tipped bracts. The spikes are elongated, the sporophylls deltoid, ovate, acuminate and bristle-tipped. The plant contains the alkaloids *lycopodine*, *clavatine* and *clavatoxine*.

**Habitat.**—Europe and Asia.

**Production and Commerce.**—The plant grows in Europe, Asia, North America and Central America. When the sporophylls are mature, the tops are

shaken and the spores collected with foreign matter. The latter is separated by sieving. Considerable of the drug is produced in Poland and the Ukraine. Switzerland, Roumania and Germany also produce it. The foreign commercial supplies used in this country come in bags within cases and, prior to World War II, were chiefly imported from Danzig, Poland, Japan, Lithuania, Russia and the United Kingdom. During 1947, 27,926 lbs. entered this country from Russia and Canada. Maine and New Hampshire are now producing a considerable amount of our present supply. Much of it is consumed by manufacturers of fireworks.

**Description.**—A very mobile powder of light yellow color and devoid of odor and taste. It floats on water, and, when boiled with it, sinks. It burns with a quick flash when thrown into a flame.

**Microscopical Characteristics.**—Chloral or water mounts exhibit the spores as spheroidal tetrahedrons from  $25\mu$  to  $40\mu$  in diameter. The exosporium or outer wall is marked by a reticulated surface, the meshes being surrounded by polygonal ridges with straight sides. When observed with the rounded surface facing downward, the upper surface is characterized by a triangular marking which represents the intersection of the 3 plane surfaces of the spore.

**Constituents.**—Fixed oil (about 50 per cent.) consisting chiefly of *lycopodium-oleic acid* containing about 2 per cent. of *lycopodic acid*; sugar, phytosterin, protein, etc.

**Uses.**—As a protective dusting powder for abraded surfaces and for preventing the adhesion of pills; in microscopy as a means of comparing with other elements and ascertaining their approximate size, and in the Wallis method of quantitative microscopic analysis.

**Adulterants.**—(1) Pine pollen, which consists of dumb-bell shaped pollen grains, each having a central convex generative cell separating 2 spherical wing cells containing air. (2) Altered corn starch colored with methyl-orange. (3) Sulfur, detected by its emission of the odor of sulfur dioxide, when the sample is ignited. (4) Starch or dextrin, detected by boiling lycopodium with distilled water, cooling and noting a bluish, purplish or reddish color on addition of iodine T.S., or by direct microscopic observation.

#### SUBDIVISION—FILICINEÆ

The group Filicineæ is the largest among the vascular cryptogams and includes all the plants commonly known as Ferns. The main axis of a typical fern is a creeping underground stem or *rhizome* which at its various nodes bears *rootlets* below and *fronds* above. These fronds are highly developed, each being provided with a petiole-like portion called a *stipe* which is extended into a *lamina* usually showing a forked venation. Some ferns possess laminæ which are lobed, each lobe being called a *pinna*. If a pinna be further divided, its divisions are called *pinnules*. The unfolding of a frond is circinate and it increases in length by apical growth. On the under surface of the laminæ, pinnæ, or pinnules may be seen small brown patches, each of which is called a *sorus*, and usually covered by a membrane called the *indusium*. Each sorus

consists of a number of *sporangia* (spore cases) developed from epidermal cells. In some ferns the entire leaf becomes a spore-bearing organ (sporophyll). Most sporangia have a row of cells around the margin, the whole being called the *annulus*. Each cell of the annulus has a U-shaped, thickened cell-wall. Water is present within these cells and when it evaporates it pulls the cell walls



FIG. 20.—*Dryopteris marginalis*, a fern whose rhizome and stipes yield the drug, known as American Aspidium.

together, straightening the ring and tearing the weak side. The annulus then recoils and hurls the spores out of the sporangium. Upon coming into contact with damp earth each spore germinates, producing a green septate filament called a *protonema*. This later becomes a green heart-shaped body called a *prothallus*. It develops on its under surface *antheridia* or male organs and *archegonia* or female organs, as well as numerous *rhizoids*. Within the antheridia

are developed motile *sperms*, while *ova* are produced within the archegonia. The many ciliate sperms escape from the antheridia of one prothallus during a wet season, and, moving through the water, are drawn by a chemotactic influence to the archegonia of another prothallus, pass down the neck canals of these and fuse with the ova, fertilizing them. The fertilized egg or oöspore divides, and redivides and soon becomes differentiated into stem-bud, first leaf, root, and *foot*. The foot obtains nourishment from the prothallus until the root grows into the soil, when it atrophies, and the sporophyte becomes independent. Unequal growth and division of labor continue until a highly differentiated sporophyte results, the mature "fern plant."

To this subdivision belong the true ferns or Filicales, which bear spores only of one kind, and the water ferns or Hydropterales, which bear spores of two kinds. The ferns used in medicine belong to the former of these.

### POLYPODIACEÆ (POLYPODIUM FAMILY)

Ferns characterized by possessing creeping rhizomes and leafy aerial fronds. The spores are formed in sporangia which are associated in dot or line-like clusters (sori) on the dorsal surface or margins of the frond or its divisions. Each spore case has an annulus. The sori are often covered by an indusium.

#### ASPIDIUM U.S.P. (ASPIDIUM)

**Synonyms.**—Male Fern, European Aspidium (*Dryopteris Filix-mas*); Marginal Fern, Marginal Shield Fern, American Aspidium (*Dryopteris marginalis*); *Fr.* Fougère mâle; *Ger.* Wurmfarne.

**Botanical Origin.**—*Dryopteris Filix-mas* (Linné) Schott and *D. marginalis* (Linné) Asa Gray.

**Part Used.**—The rhizome and stipes.

**Standard of Assay.**—Aspidium yields not less than 1.5 per cent. of crude filicin.

**Limit of Impurities.**—Not more than 3 per cent. of acid-insoluble ash; not more than 2 per cent. of foreign organic matter.

**Plants.**—Perennial ferns with oblique rhizomes which are covered with stipe bases. From the anterior region of each arises a circle of broadly oblong-lanceolate or ovate-oblong bipinnate fronds. The pinnæ or first divisions of the lamina of the frond are lanceolate and the pinnules or divisions of the pinnæ, oblong. In *D. Filix-mas* sori are nearer the midvein than the margin; in *D. marginalis* they are along the margin.

**Habitat.**—*Dryopteris Filix-mas* is native to rocky woods of Europe, Asia and North America (Newfoundland and Nova Scotia to Alaska, south to northern Vermont, northern Michigan, and along the Rockies to Arizona). *D. marginalis* is native to North America from Nova Scotia to British Columbia, south to Georgia, Alabama, Arkansas, Kansas and Oklahoma.

**Cultivation.**—Spores are collected by placing the fronds with mature sori with the sorus surface downward on a sheet of paper and covering them with a

plate or piece of window glass. A shallow earthen pot is nearly filled with a compost made of leaf mold and loam which is sterilized by pouring boiling hot water through the compost or by heating the soil in an oven at 100°C. Allow the soil and pot to completely cool and then scatter the spores which have collected on the paper over the surface of the compost. Cover the flower pot with a piece of window glass and keep in a shady place for several weeks, watering



FIG. 21.—*Osmunda Claytoniana* L. (Fam. *Osmundaceæ*), whose rhizome and stipe bases have been substituted for *Aspidium*. Note the central fronds showing sterile (leafy) pinnæ above, fertile pinnæ in middle and sterile pinnæ toward base.

from below. The prothalli (small, heart-shaped, greenish bodies) will appear in due course and, later, young sporophyte fern plants. These, when sufficiently large, should be transferred to a shady situation in soil containing leaf mold and loam, the ground being kept moist during the hot weather by daily watering. Both *Dryopteris Filix-mas* and *D. marginalis* do best in rich, moist woodland soil and shade.

**Production and Commerce.**—The ferns are uprooted in autumn, freed from roots, dead portions of rhizomes and stipes and dried at a temperature

of 70°C. Many of the rhizomes are cut longitudinally to facilitate drying. The European drug is gathered in various parts of Europe, particularly in the Harz and Thuringian mountains. It has been imported into the U.S.A. chiefly



FIG. 22.—Note passing from above downward: Stipe bases of *Dryopteris marginalis*; rhizome and roots of *Dryopteris marginalis*, the rhizome covered with stipe bases; rhizome of *Osmunda Claytoniana* covered with stipe bases and 3 separated stipe bases at its right.

from Germany and Holland. Recently Indian *Aspidium*, collected in the Kashmir district of India has been arriving on the American market.

The European article is characterized by occurring in the form of partially peeled stipes and longitudinally cut rhizomes. Indian *Aspidium* occurs as entire rhizomes with attached stipe bases.



American *Aspidium* occurs as entire rhizomes and stipe bases or as stipe bases only. It is collected in scattered parts of the eastern and central United States. New Hampshire is now the principal source of supply of this variety.

**Description.**—Rhizome cylindraceous, 1 to 3 cm. in thickness, nearly straight or curved and tapering toward one end, often split longitudinally and exhibiting large, angular stipe-scars in which the broken vascular bundles are visible, and, occasionally, adhering feathery masses of reddish-brown scales (*ramenta*), or with stipe bases attached; stipes sub-cylindrical, somewhat curved, tapering toward one end, partially peeled or unpeeled up to 5 cm. in length and about 8 mm. in thickness; externally weak reddish-brown to brownish-gray or, if peeled, light brown to weak yellow; fracture short; texture spongy; fractured surface pale green to weak greenish yellow or brown and exhibiting 2 to 13 small vascular bundles, arranged in an interrupted circle; odor slight; taste, at first, sweetish and astringent, then bitter and acrid.

Rhizomes and stipes devoid of a green color internally are typical of the Indian variety.

**Histology of Rhizome.**—Passing from periphery toward the center the following structures are to be observed:

1. **Epidermis**, a protective outer covering tissue, composed of a single layer of brownish polyhedral cells from which are given off *ramenta*.

The latter show 2 small glands at their bases and the margins have 2-celled projections.

2. **Outer cortex** (*hypodermis*), a zone of several layers of orange to greenish-orange thick-walled, lignified, hypodermal cells separating the epidermis from the inner cortex beneath.

3. **Inner cortex** of several layers of more or less isodiametric cells (cells of nearly the same length, breadth and thickness) with thin cellulose walls and containing stored starch surrounded by a protoplasmic investment. Between the cells are to be noted intercellular-air spaces, into many of which project characteristic more or less pyriform, short-stalked oleoresin glands.

4. **Pith** composed of fundamental tissue, resembling the last in aspect and function.

5. **Vascular Bundles.**—These are of two kinds, viz.: stem bundles and leaf-trace bundles. Both are of elliptical outline and of *xylocentric type* as seen in cross section, and are embedded in the parenchyma forming the broad central matrix. The stem bundles are comparatively broad and, as viewed in longitudinal sections, form a continuous network with good-sized meshes, each mesh being opposite the point of insertion of one of the leaves. In transverse section these bundles are seen to be arranged in an interrupted circle within the fundamental tissue. The leaf-trace bundles are comparatively narrow and are observed to come off of the stem-bundles and pass out through the cortex into the leaves (fronds). When each bundle is examined under a high-power magnification it is seen to consist of a central xylem, composed of scalariform or occasionally reticulate or reticulo-scalariform tracheids, which is completely surrounded by a phloem composed of rounded, thin-walled phloem

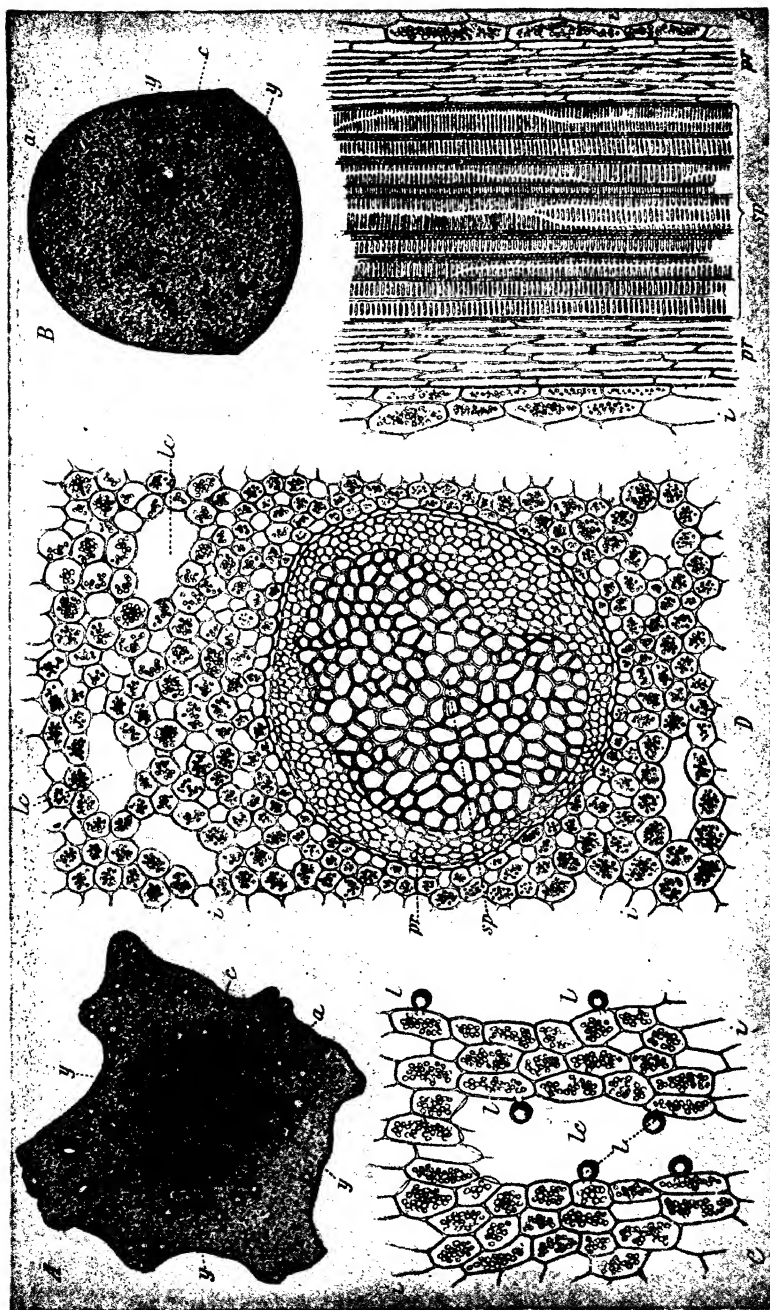


FIG. 23.—*Aspidium Filix-mas*. A. Transverse section of the rhizome, X 3. B. Transverse section of the stipe base X 5. C. Longitudinal section through a portion of the parenchyma region showing intercellular-air-spaces into which oleoresin-containing glandular hairs (l) project, X 65. D. Transverse section through a concentric bundle and adjacent parenchyma, X 65. E. Longitudinal section through the same, X 65. a, cortex; c, pith; i, parenchyma; y, xylocentric bundles; lc, intercellular-air-spaces; l, internal glandular hairs; pr, phloem; sp, scalariform tracheids. (After Berg.)

cells and sieve tubes. Surrounding the bundle is a 1 to 3-layered pericycle and around this an endodermis or bundle sheath composed of a single layer of cells with yellowish walls and granular contents.

**Histology of Stipe (Petiole).**—This, in transverse section, passing from periphery toward the center, presents the following structural characteristics:

1. **Epidermis**, a single layer of epidermal cells with dark brown outer walls. Attached to the lower portion of the stipe as epidermal outgrowths are scales

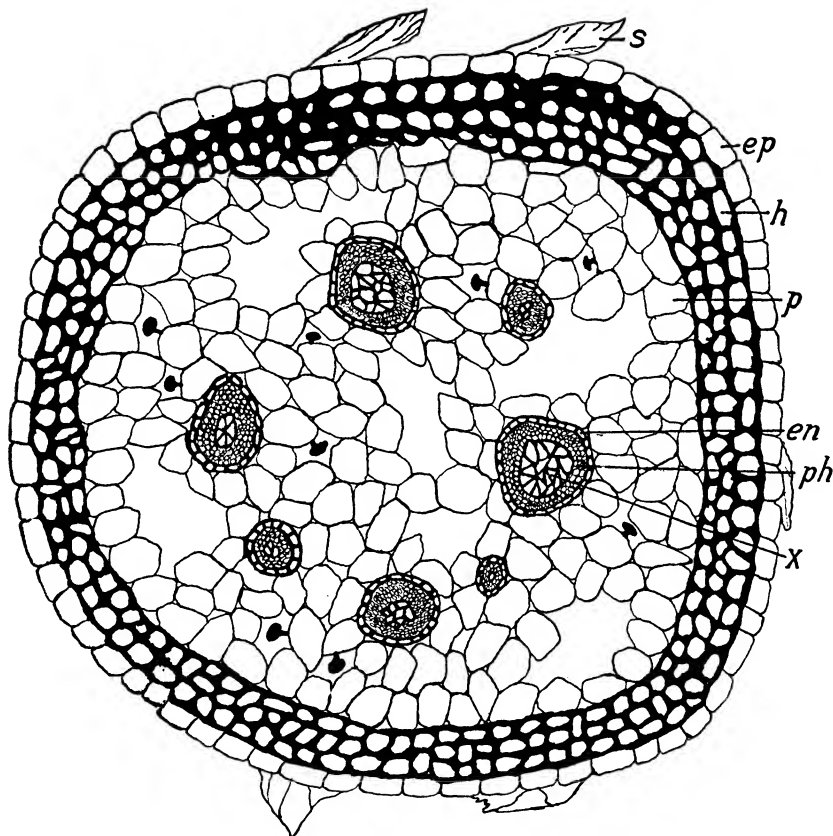


FIG. 24.—Transverse section of *Dryopteris marginalis* (American Aspidium) stipe base. Epidermis (*ep*); hypodermis (*h*); parenchyma (*p*); xylem composed mainly of scalariform tracheids (*x*); surrounded by phloem (*ph*) and forming a concentric fibrovascular bundle; endodermis or bundle sheath (*en*); ramentum (*s*). Magnified.

(*ramenta*). Each of these consists of elongated, thin-walled cells with 2-celled projections on the margin, but no glands, except at the base, where there are usually 2.

2. **Outer cortex** (hypodermis), a wide band of small cells with lignified walls.

3. **Inner cortex**, similar to inner cortex of rhizome but devoid of leaf-trace bundles.

4. **Fundamental parenchyma**, similar to same region of stem, in which are embedded 2 to 13 *xylocentric vascular bundles* arranged in an interrupted circle.

Each of these shows a central xylem mass surrounded by an outer phloem mass. Each bundle is enveloped by a 1 to 3 layered *pericycle* and an *endodermis* or bundle sheath.

**Constituents.**—A yellowish, amorphous, complex dibasic acid which constitutes the chief active tæniifuge substance and called *filmarone* and *crude filicin* ( $C_{47}H_{54}O_{16}$ ); *albaspidin*, *filicic acid*, *aspidinol*, *flavaspidic acid*, *flavaspidinol*, a green fixed oil, *filicitannic acid*, *resins*, *starch*, etc.

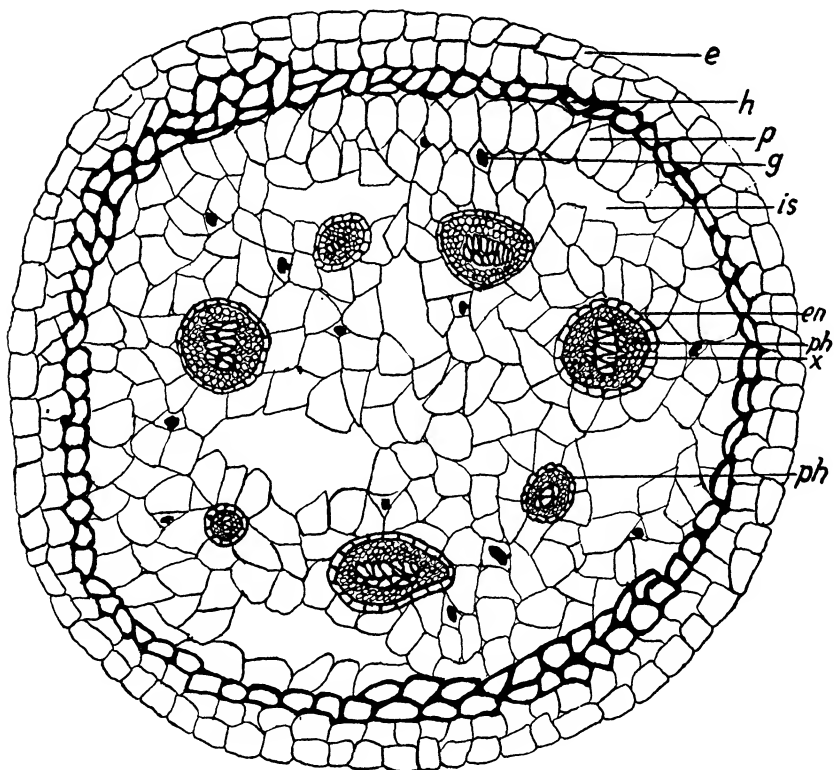


FIG. 25.—Transverse section of *Aspidium spinulosum* stipe base. Epidermis (*e*); hypodermis (*h*); parenchyma (*p*); intercellular-space (*is*); internal gland (*g*); xylem (*x*); phloem (*ph*); endodermis (*en*). Magnified.

**Use.**—*Aspidium* is employed in the form of its official oleoresin as a tæniifuge.

**Preparation.**—*Aspidium Oleoresin (Male Fern Oleoresin)*, U.S.P., 4 Gm. (1 drachm) single dose, once daily, preceded by fasting for from 12 to 48 hours and a cathartic and followed by a purge. Do not administer castor oil as it promotes absorption of the toxic principles of the drug. **Standard.**—*Aspidium Oleoresin* yields not less than 24 per cent. of crude filicin.

**Adulterants and Substitutes.**—(1) The rhizomes and stipes of *Osmunda Claytoniana* L., which may be detected by the presence of flattened stipe bases that show in transverse section one large central, more or less crescent-shaped, concentric (xylocentric) bundle that is flanked on either side by brownish masses

of sclerenchyma fibers. Moreover, the rootlets are thicker and wiry (see Figs. 21 and 22).

(2) The rhizomes and stipes of *Aspidium spinulosum* Sw., which are difficult to distinguish from the genuine drug without microscopical examination. They may, however, be detected by the examination of cross sections of the stipes and the margins of the scales. These show 6 to 8 xylocentric vascular bundles, fewer internal glands, and a less indurated hypodermis (see Fig. 25). The margins of their scales show many small glands. It is an active taenicide.

(3) The rhizomes of the Lady Fern, *Athyrium Filix-femina* L., which are characterized by showing 2 large dumb-bell shaped vascular bundles, as observed in cross-section.

(4) The old, inert, brownish, powdered drug has been admixed with powdered marshmallow leaves in order to give it the light green appearance of the recent article.

#### DIVISION IV.—SPERMATOPHYTA (PHANEROGAMIA)

Plants producing real flowers and seeds. The highest evolved division of the vegetable kingdom.

##### SUBDIVISION I.—GYMNOSPERMÆ—THE GYMNOSPERMS

The Gymnosperms comprise an ancient and historic group of seed plants which were more numerous in the Triassic and Carboniferous periods than now. They differ from the Angiosperms in several respects, viz.: they bear naked ovules on the edges or flat surfaces of leaves called carpels, while Angiosperms bear covered ones; each megaspore or embryo-sac produces within itself a bulky prothallus, in the upper portion of which originate one or more archegonia, while in Angiosperms no recognizable prothallus has been proven to exist; the stored food tissue within their seeds is prothallial tissue loaded with starch, etc., while that in Angiosperm seeds (endosperm) is developed from the endosperm nucleus; the mode of growth of their stems is always indefinite while that of Angiosperms is either indefinite or definite.

The groups still extant are the Cycads or Fern Palms, the Gnetums, the Ephedras, the Ginkgos and the Conifers. Of these the Conifers comprising over 300 species are the most numerous. Many of them yield valuable products to pharmacy and the arts.

The Conifers include the pines, spruces, hemlocks, cedars, firs, arbor vitæ, chamæcyparis, and larches. All of their number are evergreen except some of the larches and the bald cypress which drop their foliage upon the advent of winter.

##### GNETACEÆ (GNETUM FAMILY)

A small family of shrubs with upright, climbing or prostrate stems devoid of resin reservoirs and with tracheæ as well as tracheids with bordered pores in their secondary wood. The branches are opposite or fascicled in bundles of 3 or more. The leaves are opposite or rarely whorled, frequently scale-like.

The flowers are unisexual, mostly dioecious with decussate bracts, the male with 2-8 stamens, surrounded by the membranous perianth, the female flowers of a single, erect ovule with 1 or 2 integuments and a bract-like perianth which becomes hardened and frequently thickened in the fruit. The fruits of *Ephedra* are red berry-like structures. The seeds are albuminous.

EPHEDRA (EPHEDRA)

**Synonyms.**—Ma Huang, Joint Fir, Chinese Ma Huang.

**Botanical Origin.**—*Ephedra equisetina* Bunge, *Ephedra sinica* Stapf, *Ephedra distachya* Linné, and other species of *Ephedra* containing ephedrine.



FIG. 26.—E, *Ephedra equisetina*; S, *Ephedra sinica*,  $\times 96$ .

**Part Used.**—The green stems.

**Habitat.**—Central Asia from Afghanistan to the Yellow Sea.

**Plants.**—*Ephedra equisetina* is a low woody Asiatic shrub, 1 to 2 m. in height with a long conical root from which arises a much branched stem. This gives

rise to green, terete, cauline branches which are equisetum-like and longitudinally striated having nodes from which 2 to 3 branchlets arise in whorls and internodes 11 to 23 mm. long. The leaves are reduced to brownish-purple sheaths, up to 2 mm. long which surround the branches at the nodes. The flowers occur in short male and female spikes which are arranged in the leaf axils; male spike with 3-5 flowers, each of which shows 4 pairs of decussately arranged bracts, each bract subtending a membranous perianth in which the



FIG. 27.—*Ephedra sinica*. A, segment of branch,  $\times 5$ , showing longitudinally striated surface of internodes and node bearing 2 membranous, sheathing leaves, divided into subulate blades above, connate below and forming sheath. B, fruiting branch  $\times 4$ , showing the terminal, flowering, female spike in the process of maturation into a fruiting cone, the latter ellipsoidal-globose and consisting of an axis bearing 3 to 4, rarely 5 pairs of red, fleshy bracts, the uppermost pair enveloping 2 seeds.

stamen with a short filament and 7 to 8 anthers is enclosed; female spike of 1 to 2 flowers, the peduncle of which is subtended by a pair of bracts, above which occur 3 to 4 pairs of decussately arranged bracts the top pair enclosing a single flower consisting of an ovule surrounded by an urn-shaped perianth sheath. The fruit is a red, fleshy, berry-like syncarp consisting of a single, oval, purplish, bi-convex seed. It grows in the Asiatic region bounded by  $65^{\circ}$  and  $117^{\circ}$  longitude and  $35^{\circ}$  to  $52^{\circ}$  north latitude.

*Ephedra sinica* is a low shrub growing in sandy or clay soil chiefly in northern Hopeh from the sea coast at Shanhaikwan to Kalgan, west to Paotowchen, north to Shansi and Shensi. It differs from the preceding species in a number of particulars, chief of which for diagnostic purposes are the following: the plant attains a height of 30 cm., has radical branches, more or less flat, which are seldom further branched. The leaves are opposite with subulate recurved apices and form a membranous sheath 4 mm. long and loosely surrounding the branch at the node. The flowering spikes are terminal or at the upper nodes, the male spike being solitary and the

female 2-flowered. Two seeds occur in the mature female spike, each of which shows one side triangular-convex, the other side flat. The internodes are up to 60 mm. long and the length of the green stem from 3 to 30 cm. The stems are herbaceous. The green stems are longer than *E. equisetina*.

*Ephedra distachya* is a low, rigid, tufted shrub growing along the Hopeh-Shansi border in northeast China and in Europe. It attains a height of about 38 cm. with a main stem showing branching from its upper and lower parts.

The branches are greenish-yellow, rough, terete, with internodes 2.5 to 6 cm long. Its leaves resemble those of *E. sinica*.

**Production and Commerce.**—The drug is best gathered in autumn when its alkaloidal content is greatest and should be deprived of roots and, in the case of *E. equisetina*, of the woody stems and old yellow stems before being used. The green tuft of stems of *E. sinica* is severed from the woody rhizome with one cut of a sharp axe. *Ephedra equisetina* is known commercially as Mupen Mahuang and *E. sinica* as Tsaopen Mahuang. Both species are gathered in the mountainous districts of North China. The chief market is Peking. Most of the drug is imported in bales from China.

*Ephedra distachya* Linné contains both ephedrine and pseudoephedrine, but the total alkaloidal yield is about 30 per cent. less than *E. sinica*. It is collected in Central China and Europe and exported chiefly from Tientsin and Spain.

During 1947, 70,881 lbs. of Ephedra were imported into this country from China and French Morocco.

**Cultivation.**—*Ephedra sinica* may be propagated from seed or from rootstock cuttings. Seed should be planted during early spring in loam about 2 inches apart in drills about  $\frac{1}{2}$  in. deep, the soil pressed down firmly, and kept well watered until the young seedlings have appeared. The rows should be about 30 in. apart. Cultivation is necessary to keep down weeds until the plants form a sod. It has been shown by Hiner that the stems of this species increase in alkaloids yearly so that cuttings made from plants in the autumn of the fourth year yield up to 0.818 per cent. The stems should be cut in September or October and dried in the sun.

**Description.**—The drug occurs as branched and unbranched, jointed, terete or flattened green stems and branches or as the aerial part of the plant with or without the upper part of the woody root attached; fracture brittle; odor aromatic upon crushing; taste aromatic, bitter and astringent.

**Histology.**—The outline of the transverse section through the internode varies from elliptical to ovate in upper internodes becoming sub-circular in the two basal internodes, the periphery being sinuate-ridged due to longitudinal ridges and furrows on the stem surface.

The *epidermis* shows a thick cuticle and is composed of epidermal cells which are more or less quadrangular with outwardly convex walls in cross section, rectangular to irregularly hexagonal in surface section and showing rows of sunken stomata between the ridges. Papillæ are present in the ridge regions of *E. sinica*, *E. distachya*, *E. equisetina*, etc.

The *cortex* is composed of chlorenchyma and stereome, and is divisible into an outer palisade zone of radially elongated cells and an inner spongy parenchyma of somewhat polygonal cells. Starch grains, crystals, and tannin cells occur in some of the cells.

Within the ridges groups of *hypodermal fibers* having the form of a flange or triangle are evident. These are usually non-lignified. *Mesocortical fibers* are numerous and lignified to non-lignified in *E. equisetina*, less numerous and non-lignified or absent in *E. sinica* and *E. distachya*.



The *pericycle* is distinguished by the crescent of pericyclic fibers outside of each phloem region. These fibers are lignified in *E. equisetina* and non-lignified in *E. distachya* and *E. sinica*, except toward the base.

The *fibrovascular bundles* are of the open collateral type and arranged in a circle in cross section of the internodal region while at the nodes they form vascular networks. Each shows a small outer phloem composed of soft bast, a cambium and a somewhat wedge-shaped xylem, the last composed of tracheids and vessels with bordered pits and some spiral tracheæ in the protoxylem.

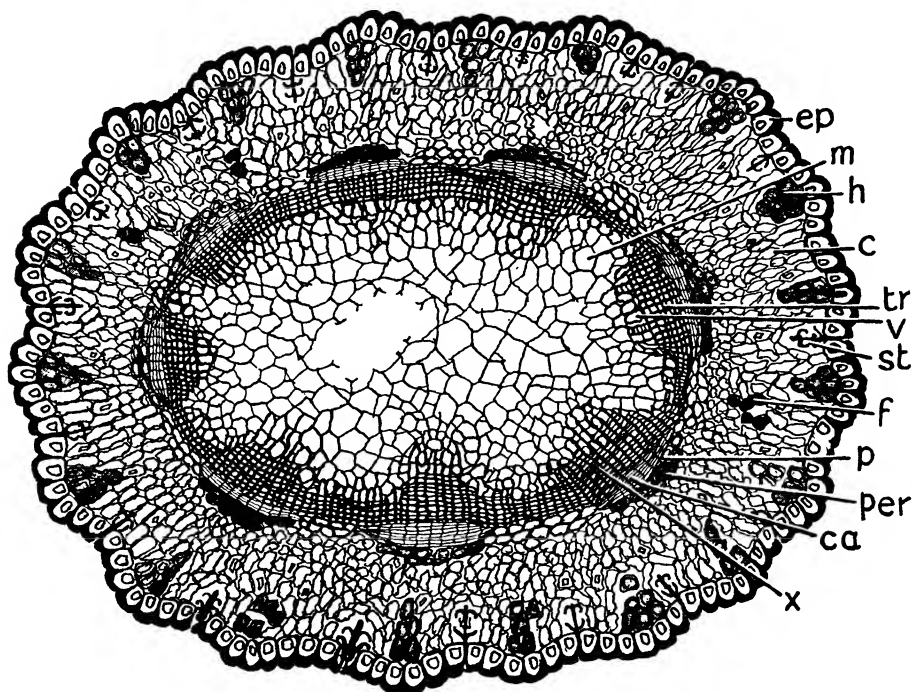


FIG. 28.—*Ephedra sinica*. Transverse section of branch, highly magnified. *Ep*, epidermis; *h*, hypodermal fibers; *c*, chlorenchyma of cortex; *tr*, tracheids; *v*, spiral trachea in protoxylem; *st*, stomatal chamber; *f*, mesocortical fibers; *p*, phloem, *per*, pericycle, *ca*, cambium, *m*, medulla and *x*, xylem of an open collateral bundle.

Primary medullary rays occur between the bundles in the young portion of the stems but in the older portions the bundles are linked by the completion of the cambium ring and the development of secondary bundles.

The number of primary bundles in the specimens examined varied from 8 in *E. distachya* and *E. Helvetica* to 8–11 in *E. equisetina* to 8–10 in *E. Gerardi-ana*, to 12 or 15 in *E. trifurca*.

Around the inner margin of the xylem strands scattered fibers called perimedullary stereome will be noted as a series of isolated fibers in *E. distachya*, *E. viridis*, *E. trifurca*, etc. Perimedullary stereome is absent in *E. equisetina* and many others. Occasional lignified perimedullary fibers occur in some sections of the two basal internodes of *E. sinica*.

The pith is composed of large and small cells usually with pitted, lignified walls except in terminal internode of *E. nebrodensis* where walls of the pith cells

# HISTOLOGICAL DIFFERENCES BETWEEN CROSS SECTIONS OF GREEN STEMS OF EPHEDRA SPECIES

	<i>Ephedra sinica</i>	<i>Ephedra equisetina</i>	<i>Ephedra distachya</i>	<i>Ephedra Gerardiana</i>	<i>Ephedra nebrodensis</i>
Outline.	Ovate to elliptical above; sub-circular toward base.	Elliptical to ovate.	Elliptical to ovate above; sub-circular toward base.	Elliptical to ovate above; sub-circular toward base.	Elliptical to ovate above; sub-circular toward base.
Average No. of ridges in terminal internode.	16	17	12	14-16	12-15
✓ Hypodermal fibers.	Usually non-lignified.	Non-lignified	Non-lignified	Lignified to non-lignified.	Non-lignified
Mesocortical fibers.	Non-lignified to few lignified toward stem base.	Lignified to non-lignified.	Non-lignified when present; usually absent	Lignified to non-lignified.	Non-lignified
✓ Pericyclic fibers.	Non-lignified except in basal internode.	Non-lignified in terminal internode, lignified elsewhere.	Non-lignified to rarely lignified at base.	Lignified except in terminal internode.	Usually non-lignified.
No. of F.V.B.	8-10	8-10, 11	8	8-10	6-10
Perimedullary fibers.	Absent except near base where rarely present & lignified.	Absent.	Lignified to slightly so in terminal internode.	Absent.	Absent.
Pith.	Lignified, to slightly so in terminal internode.	Lignified, to slightly so in terminal internode.	Lignified.	Lignified.	Non-lignified in terminal internode, lignified below.

are of cellulose excepting around the xylem masses. Mucilage sacs with colored contents occur in this region in *E. distachya*, *E. equisetina*, etc.

**Powdered Drug.**—Greenish-brown or green. Numerous thick fragments of cutinized outer walls of epidermis varying from colorless to varying shades

of brown or red; numerous fragments of sclerenchyma fibers with extremely thickened, non-lignified to lignified walls, narrow, frequently indistinct lumina and sharp pointed ends; fragments of vascular tissue showing tracheids with bordered pores and occasional spiral and pitted tracheæ; numerous chlorenchyma cells; starch grains simple, spheroidal to occasionally ovate, averagely up to  $12\mu$  but occasionally up to  $20\mu$ ; fragments of epidermis with rectangular cells and granular contents, some with sunken elliptical stomata; fragments of lignified or non-lignified pith-parenchyma, some of the cells showing mucilage sacs; papillæ; granules of calcium oxalate.

**Constituents.**—The alkaloids *l*-ephedrine (chief active principle) and pseudo-ephedrine; tannin, etc. *Ephedra equisetina* yields from 0.6 to 1.75 per cent. of

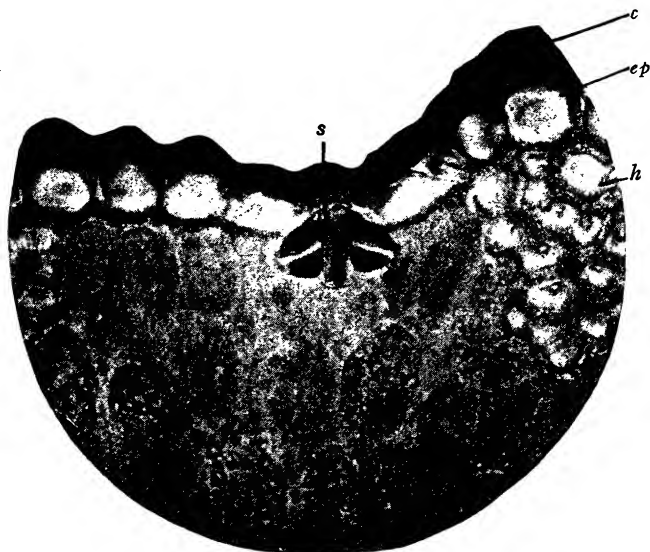


FIG. 29.—Transverse section through the outer region of the green stem of *Ephedra sinica*. Highly magnified. *c*, cuticle; *ep*, epidermis; *h*, hypodermal fiber; *s*, sunken stoma; *p*, palisade parenchyma (outer region of chlorenchyma).

total alkaloids of which 85 to 90 per cent. is ephedrine and 10 to 15 per cent. pseudo-ephedrine. *E. sinica* yields 0.438 to 1.35 per cent. of total alkaloids of which 75 to 85 per cent. represents ephedrine and 15 to 25 per cent. pseudo-ephedrine. The alkaloids increase in amount as the plants mature.

**Ephedrine U.S.P. (Ephedrina)**  $C_{10}H_{15}NO$  is an alkaloid obtained from *Ephedra sinica*, *E. equisetina* and other species of *Ephedra* (Fam. *Gnetaceæ*) or produced synthetically. It occurs in the anhydrous and hydrated forms and represents an unctuous, nearly colorless solid or white crystalline or granular substance. Its solutions are laevorotatory. Anhydrous ephedrine contains not less than 98.5 per cent of  $C_{10}H_{15}NO$ . Hydrated ephedrine contains not less than 94 per cent of  $C_{10}H_{15}NO$ . The label must declare whether the ephedrine is hydrated or anhydrous. It enters into ephedrine spray and compound ephedrine spray N.F., and from it are prepared the sulfate and the hydrochloride

of ephedrine U.S.P. The alkaloid and its salts gradually decompose on exposure to light and should be preserved in tight, light-resistant containers.

**Uses.**—The sulfate and hydrochloride of ephedrine are employed as vasoconstrictors, mydriatics and stimulants to the sympathetic nervous system; in bronchial asthma, hay fever, catarrh, hemorrhage, circulatory collapse and shock, and in ophthalmology to produce dilatation of the pupil.

**Average Dose.**—Of ephedrine sulfate or hydrochloride, U.S.P., 25 mg. ( $\frac{3}{8}$  grain).

**Preparations.**—In U.S.P.: Ephedrine Sulfate Tablets. In N.F.: Ephedrine Hydrochloride Tablets, Ephedrine Spray, Compound Ephedrine Spray, Ephedrine Sulfate Ampuls, Ephedrine Sulfate and Phenobarbital Capsules, Ephedrine Sulfate Capsules, Ephedrine Sulfate Jelly, Ephedrine Sulfate Solution (for use on mucous membranes dilute with an equal volume of isotonic sodium chloride solution), Ephedrine Sulfate Syrup, av. dose, 4 cc. (1 fl. dr.).

### PINACEÆ (CONIFERÆ) (PINE FAMILY)

Trees or shrubs with resinous juice whose wood is characterized by being composed largely of tracheids with bordered pits. Leaves entire, awl- or needle-shaped, frequently fascicled, exstipulate, usually evergreen. Flowers, monœcious or rarely diœcious, achlamydeous, in cones. Staminate cone of a large number of microsporophylls (stamens) closely packed together and arranged spirally around a central axis, each stamen bearing usually two pollen sacs. Carpellate cone composed of spirally arranged scales, each of which bears a pair of naked ovules (megaspores) near the base of its upper face, or of 3 to 6 fleshy coalescent scales, each 1-ovuled (*Juniperus*). Fruit a cone with woody or fleshy scales (*Pinus*, *Thuja*, *Abies*, *Picea*, etc.) or a galbulus (*Juniperus*). Seeds albuminous. Embryo with two or more cotyledons.

### TURPENTINE N.F. (TEREBINTHINA)

**Synonyms.**—*Gum Thus*, Crude Turpentine, *Gum Turpentine*, Lump Turpentine; *Ger.* Terpentin; *Fr.* Térébenthine commune.

**Botanical Origin.**—*Pinus palustris* Miller and other species of *Pinus*.

**Part Used.**—The concrete oleoresin.

**Limit of Impurities.**—2 per cent. of foreign organic matter.

**Habitat.**—From Virginia to Florida and Texas.

**Plant.**—*Pinus palustris* or "long leaf pine" is a large evergreen tree with thin scaly cork and hard resinous wood, growing in sandy soil in the southern states, mainly within 100 miles of the coast. Its leaves are in fascicles of 3 which range from 5 to 10 in. in length. Its cone scales are long, flattened, with short, sharp, recurved spines. *Pinus Tæda* L. (Loblolly pine), *P. caribæa* Morelet (*P. cubensis* Grisebach) (Cuban pine) and *P. echinata* Miller (Short-leaf pine) also yield some of the drug.

**Production and Commerce.**—The oleoresin is formed in resin reservoirs contained in the wood and exudes spontaneously but not in sufficient quantities to make it worth while collecting on a commercial basis. It is obtained com-

mercially by several methods. The first of these consists of cutting a series of downward and inward sloping V-shaped incisions into the trunk of the tree for a distance of about a foot, the bark and young wood being removed. This is usually done early in the year. At the base of these incisions an aluminum

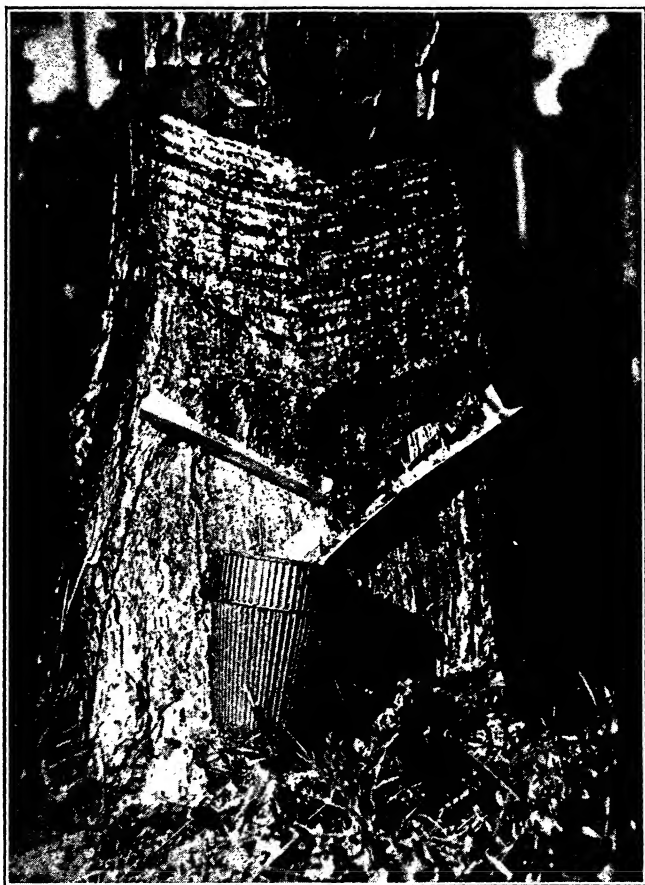


FIG. 30.—Turpentine by the cup and gutter system. Note the V-shaped metal trough inserted just above the earthen cup into which the flow of turpentine from the hacked wood is directed.

or earthenware cup is affixed to the trunk and two aluminum strips ("aprons") are inserted above to deflect the flow of the oleoresin into the cup. The oleoresin soon begins to run and collects in the cup. As the cups become filled their contents are emptied into wooden barrels and others affixed to the trees. In about a week or ten days the flow of oleoresin diminishes and another series of incisions is started above the first excavation. Production continues until autumn. This method is known as "*the cup and gutter system.*"

A second method consists of making a small narrow incision in the bark and inserting a strip of galvanized iron or aluminum. The oleoresin flows along this strip into an earthenware receptacle. Through research during World War

II, a new method of extracting gum turpentine was developed known as "*chemical stimulation*." It consists of spraying sulfuric acid on the fresh wound made by incising the bark whereby the flow of gum is stimulated and prolonged. Trees chipped weekly by this method are reported to yield 50 to 60 per cent more gum than untreated trees.

Turpentine is largely a pathological product formed in the wood of the trees due to the stimulation of the cambium, through injury, to form new wood containing large numbers of oleoresin reservoirs. "Scraps," "gum thus" or "American Frankincense" are terms applied to the white incrustation on the

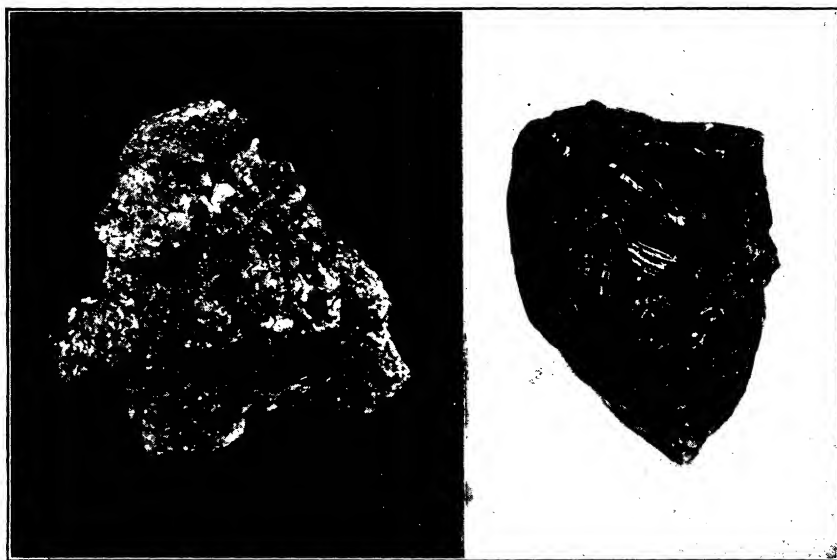


FIG. 31.—A, Turpentine; B, Rosin.  $\times \frac{1}{2}$ . (Photograph by Stoneback.)

surface of the hacked wood of the excavations, consisting of the turpentine which has dried thereon without reaching the cup. This is scraped off and marketed as a distinct article. The turpentine collected from the first year's tapping is known as "virgin" turpentine and yields from 15 to 30 per cent. of volatile oil and an amber-colored rosin. That collected during subsequent years supplies the so-called "yellow dip" turpentine which is somewhat darker in color, contains less volatile oil and yields upon distillation a yellowish-brown or yellowish-red rosin.

The commercial supplies of turpentine are obtained chiefly from Florida, Mississippi, Louisiana, Texas, North Carolina, South Carolina and Georgia. Florida and Georgia lead the country in turpentine and rosin production.

**Description.**—In yellowish-orange to yellow, irregular, opaque masses, yellowish-white internally, sticky when warm, more or less glossy, brittle in the cold; odor aromatic; taste characteristically pungent. An alcohol solution of turpentine is acid to litmus paper. It is freely soluble in alcohol, ether, glacial acetic acid and chloroform.

**Constituents.**—*Volatile oil* (10 to 30 per cent.) consisting of a mixture of several terpenes, chief among which are pinene, phellandrene, limonene and dipentene (all of them have the formula of  $C_{10}H_{16}$ ); resin (70 to 90 per cent.), *abietic anhydride* which may be converted into *abietic acid*, bitter principle, etc.

**Allied Product.**—Bordeaux turpentine is an oleoresin obtained from *Pinus maritima* Poiré and other species of *Pinus* growing in southwestern France. It contains a strongly laevorotatory volatile oil, and a resin consisting of pimaric, pimarinic and pimarolic acids.

**Uses.**—Lump turpentine is used as an ingredient in preparing Compound Rosin Cerate, N.F. or *Deshler's Salve* and some unofficial plasters. Most of the crude article is distilled for oil of turpentine and rosin.

#### TURPENTINE OIL N.F. (OLEUM TEREBINTHINÆ)

**Synonyms.**—Oil of Turpentine, *Turpentine Spirits*; Ger. Terpentinöl; Fr. Huile volatile de térébenthine.

**Definition.**—The volatile oil distilled from the oleoresin obtained from *Pinus palustris* Miller and other species of *Pinus* (Fam. *Pinaceæ*) which yield terpene oils exclusively.

**Production.**—Crude turpentine is placed in a large copper retort connected through a goose-neck cap and "worm" (condenser) with a receptacle. The retort is heated and the turpentine oil vapor passes into the "worm," extended in a tank of cold water, where it condenses as oil and empties into the receptacle. Upwards of 3,000,000 gallons of oil of turpentine are produced in the United States annually.

**Description.**—A colorless liquid possessing a characteristic odor and taste, soluble in 5 volumes of alcohol; sp. gr. 0.854–0.868 at 25°C.; opt. rot. variable; ref. ind. 1.4680–1.4780 at 20°C.

**Constituents.**—The bicyclic terpenes *alpha-pinene* (55–65 per cent) and *beta-pinene* (25–35 per cent), the monocyclic terpenes *dipentene* and *terpinolene*, methyl chavicol, the alcohols pinocarveol and pinocarveol hydrate, bornyl acetate, alkyl ethers, esters, paramenthane, phenols and phenolic hydroxy compounds.

**Uses.**—As a stimulant and counterirritant in liniments, in the form of a stupe as a counterirritant in deep seated inflammations; as a solvent in the arts.

**Adulterants.**—Petroleum distillates.

**Preparations.**—Turpentine Liniment (Kentish Ointment), Acetic Turpentine Liniment, N.F. (St. John Long's Liniment, Linimentum Album).

**Rectified Turpentine Oil, N.F.** (Oleum Terebinthinæ Rectificatum) is turpentine oil purified by distilling a mixture of the oil and a solution of sodium hydroxide, separating the clear oil from the distillate, drying it by shaking with anhydrous calcium chloride, and filtering. It is the kind of turpentine oil to be dispensed when that oil is required for internal use. It is employed as a diuretic and counterirritant. Av. dose, 0.3 cc. (5 minims). Preparation.—Turpentine Oil Emulsion, N.F. Av. dose, 2 cc. ( $\frac{1}{2}$  fl. dr.).

**Allied Product.**—**Wood Turpentine** is a volatile oil distilled from the wood of *Pinus palustris* Miller and other species of *Pinus*. The stumps of the turpentine yielding pines are either pulled out of the earth or blown out with dynamite, then ground to chips, placed in a retort and live steam passed through the chips. The vapors pass through coils at the top of the retort and are condensed as a liquid. The liquid is then passed through a refining system, if first quality oil boiling within the range of Turpentine Oil produced from the oleoresin is to be obtained. It contains alpha-pinene (80 to 85 per cent), beta-pinene (0 to 2 per cent), camphene (3 to 8 per cent), other terpenes (10 to 15 per cent) including dipentene, terpinenes and terpinolene, the terpene alcohols alpha-terpineol, borneol and fenchyl alcohol, methyl chavicol, and traces of phenols, camphor, cineol, sobrerol, benzaldehyde and furfural. It is used in the manufacture and thinning of paints and varnishes, as a solvent, and in the manufacture of synthetic camphor.

**Terpin Hydrate (Terpini Hydras) N.F.** is a product made by the hydration of the pinenes in turpentine oil. It is used as a stimulating expectorant in bronchitis. Dose 2 to 4 grains. Preparations: Terpin Hydrate Elixir, N.F., 4 cc., Terpin Hydrate and Codeine Elixir, N.F., 4 cc.

#### PINE OIL N.F. (OLEUM PINI)

**Definition.**—A volatile oil composed chiefly of tertiary and secondary terpene alcohols obtained by extraction and fractionation or by steam distillation of the wood of *Pinus palustris* Miller and other species of *Pinus* (Fam. *Pinaceæ*).

**Description.**—A colorless to light amber liquid having an agreeable pineaceous odor; miscible with alcohol; sp. gr. 0.925 to 0.937 at 25°C.; ref. ind. 1.4810 to 1.4840 at 20°C.

**Uses.**—In pharmacy, for the preparation of Pine Oil Emulsion Concentrate, N.F. and in the manufacture of some disinfectants; in industry, for the treatment of cotton, wool and rayon fabrics before dyeing, in the manufacture of some soaps and insecticides, in the devulcanization and reclaiming of rubber, in commercial laundering, and in the flotation process for the concentration of ores of copper, zinc, lead, etc.

#### ROSIN N.F. (RESINA)

**Synonym.**—*Colophony*, Yellow Pine Rosin; *Ger.* Geigenharz, Fichtenharz; *Fr.* Colophone ou Arcanson.

**Botanical Origin.**—*Pinus palustris* Miller and other species of *Pinus*.

**Part Used.**—A solid resin (the residue left after distilling the volatile oil from Lump Turpentine).

**Production and Commerce.**—The crude turpentine is dipped out of the "cups" in which it gathers, placed in barrels and hauled to the turpentine still. The still consists of a large copper kettle or retort having a capacity of 20 to 30 barrels, a goose-neck cap and "worm." The "worm" passes through a tank of cold water and ends above a receptacle arranged to receive the oil of turpentine.



Below the retort is a furnace in which a hot wood fire is kindled. The retort is half filled with the crude turpentine or "dip" and water is added to prevent scorching. Distillation commences at about 300°F. and the mixture of steam and oil of turpentine pass through the coil or worm, condensing as it cools and passing into the receptacle. The oil is drawn off into tanks or barrels while the molten rosin is released from the retort by opening the "tail gate." It passes through a set of screens into a vat, from which it is dipped into barrels, allowed to harden and graded. Most of the rosin is produced in the southern states but some is imported from Mexico, England and Greece.

**Description.**—It occurs in irregular, more or less angular, light or dark amber-colored masses or sharp fragments, frequently covered with a yellowish dust, brittle at ordinary room temperature, translucent; fracture shallow-conchoidal; odor and taste slightly terebinthinate. It burns with a dense, yellowish smoke. It is soluble in alcohol, ether, benzene, fixed and volatile oils, glacial acetic acid and is dissolved by dilute solutions of fixed alkaline hydroxides. Its specific gravity is 1.07 to 1.09 at 25°C. Its acid value is not less than 150.

**Constituents.**— $\alpha$ -  $\beta$ - and  $\gamma$ -*abietinic* (abietic) *acid* which represent isomeric forms of abietic acid anhydride, resene, etc.

**Uses.**—Rosin is used because of its stimulating properties as an ingredient in Rosin Cerate and Deshler's Salve, as well as in some plasters and ointments. It is also employed as an ingredient of some varnishes, and as a size for paper, in the manufacture of soap, linoleum, roofing, adhesive tapes, printer's ink, rosin oil and rosin spirit, etc.

**Preparations.**—Rosin Cerate, N.F. Compound Rosin Cerate, N.F., Turpentine Liniment (Kentish Ointment), N.F. (from Rosin Cerate).

#### LARCH TURPENTINE (TEREBINTHINA LARICIS)

**Synonym.**—Venice Turpentine, *Ger.* Venetianischer Terpentin; *Fr.* Térébenthine de Venise.

**Botanical Origin.**—*Larix decidua* Miller (*Larix europæa* DC.)

**Part Used.**—The viscid oleoresin.

**Habitat.**—Alps and Carpathian mountains of Europe extending into Siberia.

**Plant.**—A deciduous conifer, with narrowly linear leaves and cones  $\frac{3}{4}$  to  $1\frac{1}{2}$  in. long with orbicular scales.

**Production and Commerce.**—The European Larch is cultivated extensively in the Alps and Carpathians for its oleoresin. This is procured by boring holes into the wood in the spring and conducting the exuded oleoresin by gutters into tubs. It is then filtered through sieves. The commercial supplies are obtained from France, Italy and southern Europe.

**Description.**—A yellowish-green, thick, heavy liquid, having an aromatic odor and a bitter, pungent taste. It is soluble in alcohol, chloroform, acetone or glacial acetic acid.

**Constituents.**—*Volatile oil*, *acid resins* consisting mainly of  $\alpha$  and  $\beta$ -larinolic acid (amorphous) and laricinolic acid (crystalline); bitter principle, etc.

**Uses.**—As an antiseptic protective in veterinary practice and as a mounting medium in microscopy.

**Adulterant.**—Rosin oil. This may be detected by the use of reflected light. Rosin oil, in a sample thus examined, exhibits a violet or purple fluorescence, whereas Venice Turpentine shows a slight greenish fluorescence.

#### CANADA TURPENTINE (TEREBINTHINA CANADENSIS)

**Synonyms.**—Balsam of Fir, Canada Balsam; Indian Balsam; *Fr.* Baume du Canada; *Ger.* Canadischer Balsam.

**Botanical Origin.**—*Abies balsamea* Miller.

**Part Used.**—The oleoresin.

**Habitat.**—Northern United States and Canada.

**Plant.**—The Balsam Fir is a handsome evergreen tree attaining a height of 50 to 80 ft. and a trunk diameter of 15 to 30 in. Its leaves (needles) are  $\frac{1}{3}$  to  $1\frac{1}{4}$  in. long, linear, obtusely pointed or emarginate, shiny dark green above, paler below. Its carpellate cones are at first purplish, later becoming yellowish-brown, up to 4 in. long and erect on the upper side of spreading branches. Each of these cones shows a series of spirals of thin, obovate, serrulate scales (bracts) which are tipped with a short, slender point. The bark contains numerous oleoresin vesicles.

**Production and Commerce.**—The oleoresin commonly known as Balsam of Fir is secreted in oleoresin reservoirs in the bark of the tree but also collects in cavities which appear like blisters on the exterior of the trunk and branches. The blisters are punctured by collectors with the pointed spout of a collecting can and the oleoresin allowed to run into the can. The greater bulk of the commercial supply is produced in lower Canada, particularly in Quebec, although some is also collected in Maine.

**Description.**—A pale yellow, viscid, transparent liquid often exhibiting a slight greenish fluorescence, soluble in all proportions of ether, chloroform, oil of turpentine or benzene, but only partially soluble in alcohol; odor agreeable, terebinthinate; taste bitter and acrid. It dries to a solid, transparent film on evaporation.

**Constituents.**—*Volatile oil* composed chiefly of *l*-pinene (16 to 24 per cent.); *resin* (70 to 80 per cent.) and bitter principle. About 20 per cent. of the resin is canado-resene which is insoluble in alcohol, the remainder being composed of two amorphous resin acids ( $\alpha$ - and  $\beta$ -canadinolic acids) and about 0.5 per cent. of crystalline canadolic acid.

**Uses.**—Canada Balsam is chiefly used as a microscopic mounting medium and as a cement for optical lenses, for which purposes it is dissolved in xylol, after warming. It is also employed in the preparation of printing inks and occasionally as a pill excipient for very deliquescent salts.

**Allied Drugs.**—Oregon Balsam, yielded by *Pseudotsuga taxifolia* Brit. (*P. Douglasii* Carr), an evergreen conifer found in Western N. A. from British Columbia to Mexico, dries to a sticky film upon evaporation.

Alsatian Turpentine is yielded by *Abies alba* Miller, a European fir.

## PINE TAR U.S.P. (PIX PINI)

**Synonyms.**—*Pix Liquida*, Wood Tar, *Ger.* Theer; *Fr.* Goudron végétal.

**Botanical Origin.**—*Pinus palustris* Miller and other species of *Pinus*.

**Part Used.**—A product obtained by the destructive distillation of the wood.

**Habitat.**—Southern United States.

**Plant.**—See under *Turpentine*.

**Production.**—The wood of several of the pines indigenous to the Southern United States, notably *Pinus palustris*, *P. Tæda* and *P. rigida*, is cut into billets which are distilled without access of air. The tarry liquid is then separated from the liquid consisting of pyroligneous acid, wood naphtha, etc., and poured into barrels for shipment.

**Description.**—It occurs as a viscid, blackish-brown, non-crystalline liquid, translucent in thin layers, becoming granular and opaque upon ageing; odor empyreumatic, terebinthinate; taste pungent and empyreumatic. It is slightly soluble in water and miscible with alcohol, ether, chloroform, glacial acetic acid and with fixed and volatile oils.

Upon distillation, tar gives off oil of tar and pyroligneous acid, the residue left in the retort being *pitch*.

**Constituents.**—*Phenol*, *cresols*, *creosote*, *guaiacol*, acetic acid, acetone, xylol, toluol, methyl-alcohol, catechol, paraffins and empyreumatic substances.

**Uses.**—As a local irritant and stimulating antiseptic in certain skin diseases chiefly in the form of the official ointment; internally as a stimulating expectorant and diuretic. Creosote is obtained from tar by distillation.

**Average Dose** (unof.)—0.5 Gm. (8 grains).

**Preparations.**—**Pine Tar Ointment** (Unguentum Picis Pini), U.S.P.

**Allied Product.**—**Coal Tar (Pix Carbonis)** U.S.P. also known as *Pix Lithanthracis* is the tar obtained as a by-product during the destructive distillation of coal. It is a nearly black, thick liquid or semi-solid with a naphthalene-like odor and a sharp, burning taste. It is employed locally to combat inflammations and relieve itching in certain skin diseases as eczema, prurigo, lichen ruber, etc. When it is subjected to fractional distillation, it yields many fractions employed as starting points in the manufacture of numerous coal tar derivatives used in medicine, industry and the arts. **Preparations:** In U.S.P.: Coal Tar Ointment. In N.F.: Coal Tar Solution (Liquor Picis Carbonis), Chloroformic Coal Tar Solution (Liquor Picis Carbonis Chloroformicus).

## RECTIFIED TAR OIL N.F. (OLEUM PICIS RECTIFICATUM)

**Synonyms.**—Pine Tar Oil, *Oleum Picis Liquidæ Rectificatum*; *Ger.* Theeröl; *Fr.* Huile volatile de Goudron.

**Definition.**—The volatile oil from pine tar, rectified by steam distillation.

**Description.**—A thin, dark reddish-brown liquid with a strong empyreumatic odor and taste; sp. gr. 0.960 to 0.990 at 25°C.

**Constituents.**—Creosote, guaiacol, etc.

**Uses.**—It is used internally as a stimulating expectorant in the form of an emulsion, on sugar or in a capsule, or added to boiling water for inhalation.

It is an ingredient in ointments, as compound ointment of tar, etc. which are applied externally as stimulants and antiseptics in various skin diseases.

**Average Dose** (unof.).—0.2 cc. (3 minims).

**Preparation.**—Compound Tar Ointment (Unguentum Picis Compositum), N.F., Pine Tar Syrup (Syrupus Picis Pine), N.F., 10 cc. (2½ fl. dr.).

#### CRESOL U.S.P. (CRESOL)

**Definition.**—Cresol is a mixture of isomeric cresols obtained from coal tar.

**Description.**—A colorless, yellow, brownish-yellow or pinkish, highly refractile liquid, with a phenol-like or empyreumatic odor; sp. gr. 1.030 to 1.038 at 25°C. It becomes darker with age or on exposure to light.

**Identity Test.**—A saturated aqueous solution becomes bluish-violet on the addition of ferric chloride T.S.

**Uses.**—Surgical germicide and antiseptic, usually in the form of the diluted saponated solution, gastro-intestinal antiseptic. Dose, 1 minim, diluted.

**Preparation.**—Saponated Cresol Solution (Liquor Cresolis Saponatus), U.S.P.

#### BURGUNDY PITCH (PIX BURGUNDICA)

**Synonyms.**—*Ger.* Burgunder Harz, Burgundisches Pech; *Fr.* Poix de Bourgogne; Poix Blanche; Poix Jaune.

**Botanical Origin.**—*Picea Abies* (L.) Karst. [*Picea excelsa* Link.; *Abies excelsa* Poiret].

**Part Used.**—An oleoresinous exudation obtained from the stem.

**Habitat.**—Europe, in mountainous districts. Naturalized in North America.

**Plant.**—The *Picea Abies* or Norway Spruce is a handsome evergreen tree attaining a height of up to 150 ft. with spreading branches, reddish-brown bark and dense dark green foliage. Its leaves are quadrangular, acute, glossy and from ½ to 1 in. in length. It bears staminate and carpellate cones, the carpellate being conical, purplish when young, at length becoming cylindric-oblong, light brown and up to 7 in. long, the scales being obovate with erose denticulate margins.

**Production and Commerce.**—The Norway Spruce grows abundantly in Scandinavia, the Black Forest, Jura mountains and in Finland. The drug is now obtained chiefly from the Swiss side of the Juras in the forests of Soulec and Tramelan by making deep incisions with an axe in the bark, extending into the wood. The oleoresin, naturally occurring in the secretion reservoirs therein, is thus induced to flow and collects in the incisions and between the bark and wood, and solidifies. In due course of time it is scraped out, melted in copper boilers under water, poured into a coarse cloth sack from which it is pressed by a wooden lever weighted on one end, and finally kneaded with water and separated from it.

The commercial supplies come from Switzerland, Finland, Italy and Germany.

**Description.**—An opaque or translucent, yellowish-brown to reddish-brown, hard substance, taking on the form of the container in which it is kept; brittle,

breaking with a conchoidal fracture: soluble in strong alcohol and glacial acetic acid; odor aromatic; taste sweet and aromatic.

**Constituents.**—Chiefly resin consisting of  $\alpha$ - and  $\beta$ -picea-pimarolic acids (47 per cent.) with smaller quantities of picea-pimarinic and picea-pimaric acids and juro-resene; volatile oil (30 per cent.); bitter principles.

**Use.**—Counter-irritant in plasters.

**Substitute.**—Factitious Burgundy Pitch composed of a mixture of rosin, turpentine and palm oil. This article differs from the authentic drug in being incompletely insoluble in twice its weight of glacial acetic acid.

#### WHITE PINE N.F. (PINUS ALBA)

**Synonyms.**—*White Pine Bark*, Weymouth Pine.

**Botanical Origin.**—*Pinus Strobus* Linné.

**Part Used.**—The dried inner bark.

**Purity Rubric.**—Not more than 1.5 per cent. of adhering outer bark and not more than 0.2 per cent. of other foreign organic matter. It yields not more than 0.5 per cent. of acid-insoluble ash.

**Habitat.**—In forests of eastern and central North America.

**Plant.**—An evergreen timber tree having a trunk  $1\frac{1}{2}$  to 3 feet in diameter and attaining a height of 90 to 125 feet. At varying distances above the soil there arise whorls of lateral branches (3 to 7 in a whorl) at various levels becoming increasingly shorter up to the apex. These branches and their secondary branches end in terminal scaly buds. The spur shoots bear soft, flexible, bluish-green needles which are up to 5 in. in length, when mature, and occur in clusters of 5, each cluster being surrounded at its base by a deciduous sheath. The staminate cones are yellow and ovate and appear clustered at the base of the new growth about May. The young carpellate cones are pinkish-purple and occur in solitary fashion or in small groups, lateral along the new growth in early summer. The fruit is a slightly curved cone, 5 to 10 in. in length, having thin, unarmed scales.

**Production and Commerce.**—The bark is stripped from the trunk and branches in long sheets and the cork and some of the cortex removed. It is then carefully dried. The commercial supplies are chiefly obtained from the northern United States.

**Description.**—In flat, cut and broken pieces of variable size and from 1 to 3.5 mm. in thickness; sometimes folded; outer surface varying from light brown to weak yellowish-orange, coarsely striated, occasionally with small patches of brown to gray-brown periderm adhering and frequently showing small scattered pits; inner surface weak orange to yellowish-orange, finely striated longitudinally and transversely corrugated; fracture short, irregular; fractured surface showing a yellowish fibrous surface; odor slightly terebinthinate; taste slightly mucilaginous, sweet, then bitter and astringent.

**Histology.**—Sections of White Pine bark exhibit a broad phloem composed of tangential bands of more or less compressed sieve alternating with phloem

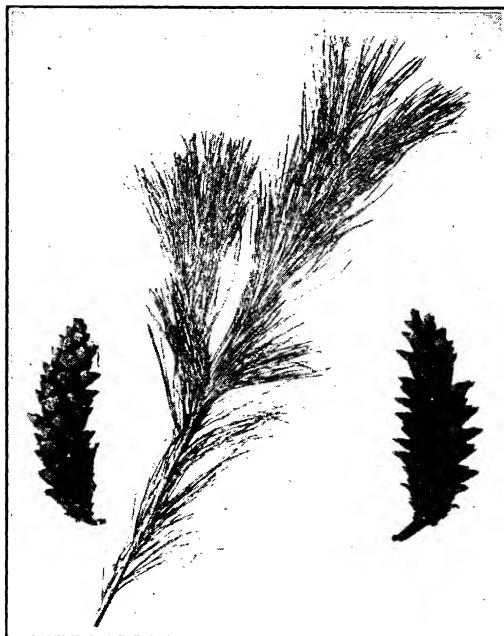


FIG. 32.—Branch bearing leaves of The White Pine (*Pinus Strobus*). On either side a carpelate cone of this species.

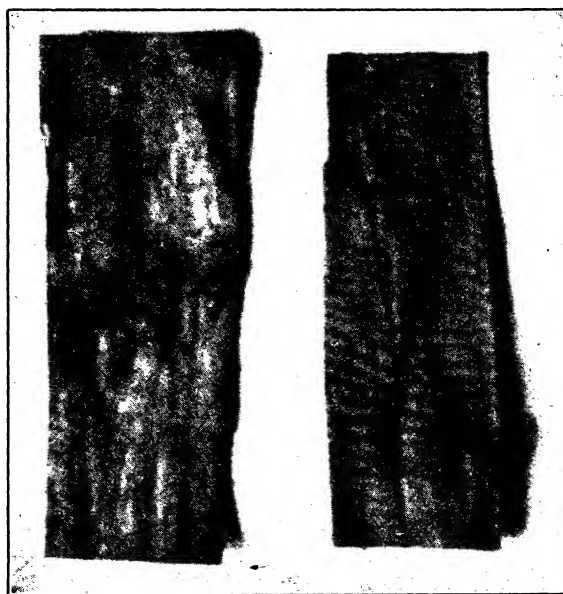


FIG. 33.—White Pine bark. Outer surface at left; inner corrugated surface at right.  $\times \frac{3}{8}$ .

parenchyma, and transversed by wavy medullary rays, 1 to 4 cells in width and up to 12 cells deep; sieve tubes showing sieve plates on the longitudinal walls; phloem parenchyma containing resin, starch, and occasionally mono-

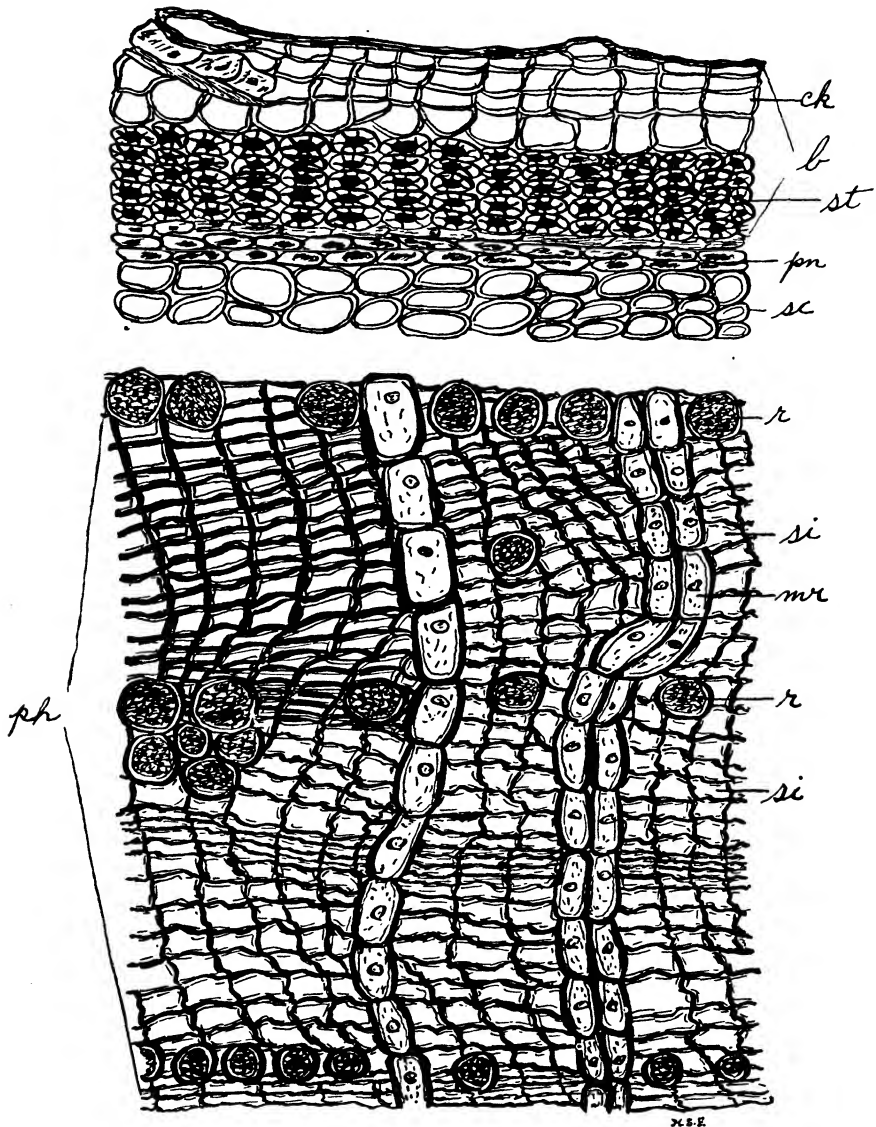


FIG. 34.—White Pine Bark. Transverse section. *b*, borke; *ck*, cork; *st*, stone cells; *pn*, phellogen; *sc*, secondary cortex; *ph*, phloem; *r*, secretion cell with resin content; *si*, sieve tissue; *mr*, medullary ray. [After Youngken and Feldman in Bull. Nat. Formulary Com., 9 (1941) 160.]

clinic prisms of calcium oxalate; interspersed with elongated fiber-like cells with thin unligified walls and occasional short fiber-like cells containing calcium oxalate prisms embedded in a resinous material. Pieces with adherent periderm possess, in addition, an outer borke zone composed of thick-walled cork cells

and starch-bearing parenchyma cells, and interspersed with large rounded, to irregularly oval secretion cells; 1 to 2 sclerenchyma bands, each of 4 to 6 layers of small stone cells with lignified walls and distinct, radiating pore canals, and one or more collapsed layers of phellogen.

**Powdered Drug.**—Weak yellowish-orange to light yellowish-brown; numerous fragments of sieve tube groups and fiber-like cells, some crossed by medullary rays; thin-walled parenchyma cells, isodiametric or elongated cells containing chiefly starch grains, occasionally monoclinic prisms of calcium oxalate; numer-

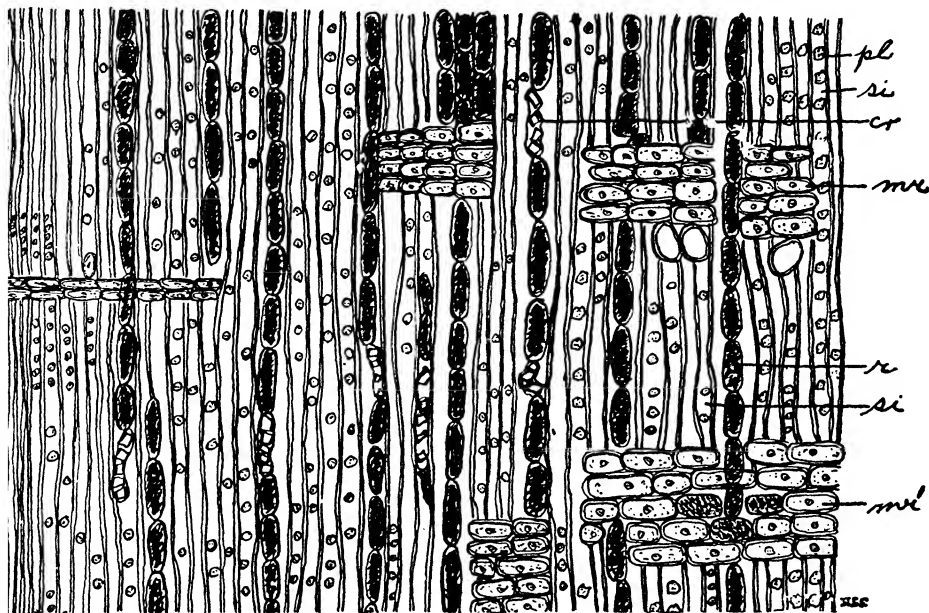


FIG. 35.—White Pine Bark. Radial-longitudinal section. *si*, sieve tubes with sieve plates (*pl*) on their longitudinal walls; *cr*, monoclinic prisms of calcium oxalate which are imbedded in a brownish, resinous substance in a fiber-like cell; *mr* and *mr'*, medullary rays; *r*, secretion cell with resin. [After Youngken and Feldman, *Bull. Nat. Formulary Com.*, 9 (1941) 161.]

ous simple starch grains of spheroidal, oval, ellipsoidal or club-shape and up to  $35\mu$ , some with a cleft through the center; few monoclinic prisms up to  $25\mu$  in length; numerous tannin cells; secretion sacs containing chiefly mucilage but often oleoresin or orange to reddish brown angular masses of resin. Bast fibers are absent, but a few lignified tracheids are usually found from adhering wood. Occasional fragments of periderm cork tissue with stone cells occur in some samples.

**Constituents.**—Tannic acid, volatile oil, resin, mucilage, starch, calcium oxalate, etc.

**Uses.**—Stimulating expectorant; in the preparation of cough syrups.

**Average dose,** 2 Gm. (30 grains).

**Preparations.**—Compound White Pine Syrup, N.F. (Stimulating expectorant) 4 cc. (1 fl. dr.) Compound White Pine Syrup with Codeine, N.F. (Sedative expectorant) 4 cc. (1 fl. dr.).



**Adulterants.**—The ground drug has been adulterated with elm bark and with the wood of the white pine.

#### JUNIPER N.F. (JUNIPERUS)

**Synonyms.**—*Juniper-berries*; Horse Savin Berries; *Ger.* Wachholderbeeren; *Fr.* Baies de Genièvre.

**Botanical Origin.**—*Juniperus communis* Linné and its var. *depressa* Pursh.

**Part Used.**—The dried ripe fruit.

**Standard of Assay.**—Juniper yields not less than 0.5 cc. of the volatile juniper oil from each 100 Gm. of drug.

**Purity Rubric.**—Juniper contains not more than 10 per cent. of immature or discolored fruits of the plant and not more than 3 per cent. of foreign organic matter, other than immature or discolored fruits, and yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—In dry woods of United States and Canada, Europe, Asia and Northern Africa.

**Plants.**—*Juniperus communis* is a low evergreen tree or erect shrub, sometimes attaining a height of 30 ft., having thin, straight, long, acerose leaves, white glaucous on the lower surface, arranged in whorls of 3, and diœcious flowers. The carpellate cones are ovoid and consist of 3 fleshy scales, each one-ovuled. The fruit is a subglobose galbulus 5 to 8 mm. in diameter which contains 3 seeds. The variety *depressa* Pursh. or Low Juniper is a decumbent or depressed shrub usually up to about 3 ft. high, forming circular mats. Its leaves have a white stripe beneath and its fruit is a blue galbulus up to 10 mm. in diameter.

**Production and Commerce.**—The fruits are collected when ripe and carefully dried. They are imported from Spain, Italy, Yugoslavia, Hungary, Russia and Canada. The fruits of the variety *depressa* were collected on a large scale in New England during World War II to replenish the dwindling stock pile of the imported drug. When recently gathered they possess a slightly more terebinthinate flavor than those of European Juniper but the latter diminishes appreciably after storing the fruits for a year or longer. The oil of juniper has been imported from Spain, Italy, Yugoslavia, Czechoslovakia, Germany and Netherlands.

**Description.**—Subgloular, 5 to 10 mm. in diameter; externally smooth, shining, purplish black to dusky red purple, occasionally reddish brown or sometimes, usually in the var. *depressa*, covered with a blue-gray bloom; at the summit a 3-rayed furrow marks the cohesion of the three fleshy bracts forming the pericarp; internally exhibiting a yellowish brown to dusky yellow flesh containing many large schizogenous cavities; seeds usually 3, triangular ovate, hard, brown, on the surface of which are large uneven oil glands; odor aromatic upon crushing; taste sweet, pleasant, terebinthinate, slightly bitter.

**Histology.**—Transverse sections exhibit the following structure:

1. **Pericarp** (mature connate bracts) composed of an outer layer of *epicarp* cells, rounded-polygonal in surface view, with thick walls and brownish

granular contents which at the sutures where the bracts meet become extended into blunt papillæ, a *hypodermis* of 2 to 3 layers of collenchyma cells with brownish red contents, a broad *sarocarp* of thin-walled loose parenchyma and large air spaces, traversed by fibro-vascular bundles with areolated fibers and oval oil reservoirs, and an *endocarp* of small, thick-walled cells, many containing crystals of calcium oxalate.

2. **Seeds** (3 in number). Each consists of a *seed coat* composed of 2 layers of thin-walled cells, a zone of 2 to 10 or more rows of thick-walled stone cells, many of which contain prismatic crystals of calcium oxalate, a layer of compressed cells and an inner epidermis of thin-walled cells. Beneath the seed coat is a zone of *endosperm* surrounding an *embryo*, both of which contain cells rich in aleurone and fixed oil.

**Powdered Drug.**—Moderate brown to dark yellowish-brown; numerous fragments of somewhat *polygonal epicarp cells of the pericarp containing a brownish granular substance*; fragments of collenchyma cells with brownish-red contents from hypodermis; fragments of *groups of stone cells*, the latter up to  $145\mu$  in length, *some containing monoclinic prisms from  $5\mu$  to about  $30\mu$  in length*; isolated *monoclinic prisms of calcium oxalate*; fragments of *endosperm* containing aleurone grains and oil globules; fragments of loose pulp parenchyma containing a brownish substance; fragments of oil glands and resin masses.

**Constituents.**—From 0.5 to 1.5 per cent of a *volatile oil* (N.F.) containing the terpenes *camphene* and  *$\alpha$ -pinene*, a sesquiterpene called *cadinene*; terpene alcohols, one of which is terpineol; resin, fixed oil, up to 30 per cent. of dextrose, etc. A crystalline substance deposits in the oil at low temperatures known as juniper camphor.

**Uses.**—As a stimulant and stimulating diuretic in cystitis.

**Average dose,** 4 Gm. (60 grains).

**Preparations.**—Elixir Buchu, Juniper and Potassii Acetate N.F., 4 cc. (1 fl. dr.)

**Juniper Oil N.F. (Oleum Juniperi)** is the volatile oil distilled with steam from the dried ripe fruit of *Juniperus communis* L. and its var. *depressa* Pursh. A colorless or faintly green or yellow liquid with the odor of juniper berries and an aromatic, bitter taste; sp. gr. 0.854 to 0.879 at  $25^{\circ}\text{C}$ .; optical rotation, 0° to not more than  $-15^{\circ}$  in a 100 mm. tube at  $25^{\circ}\text{C}$ .; refractive index, 1.4740 to not more than 1.4840 at  $20^{\circ}\text{C}$ . Stimulant and stimulating diuretic in chronic genito-urinary disorders. Av. dose,  $1\frac{1}{2}$  minims.

**Savin (Sabina)** or Savin Tops consists of the young green tops of the twigs of *Juniperus Sabina* L., an evergreen shrub native to the mountains of central and southern Europe to Siberia. The drug is gathered in the spring chiefly in the Alps and Great Britain. It occurs as thin twigs, averagely from 1 to 3 cm. long and 1 to 2 mm. thick, densely covered with 4 rows of appressed, scale-like, imbricated rhomboid leaves, each about 2 mm. long and with an oil gland directly under its dorsal surface; odor terebinthinate; taste bitter, resinous and acrid.

It contains *volatile oil* (Savin Oil) containing sabinene, terpinene, pinene,

cadinene and a terpene alcohol called *sabinol* and the ester, *sabiny acetate*, 2 to 5 per cent.; tannin and resin. It was formerly used as a uterine stimulant, emmenagogue, diuretic, local irritant, in amenorrhea, atonic menorrhagia, etc. **Preparations.**—Savin Fluidextract (unof.) (15 minims); Savin Oil (unof.) (1½ minims). The oil is a powerful irritant to the gastrointestinal mucous membrane and genito-urinary tract and has caused death in a number of cases of attempted criminal abortion, where poisonous doses were given. **Adulterants.**—

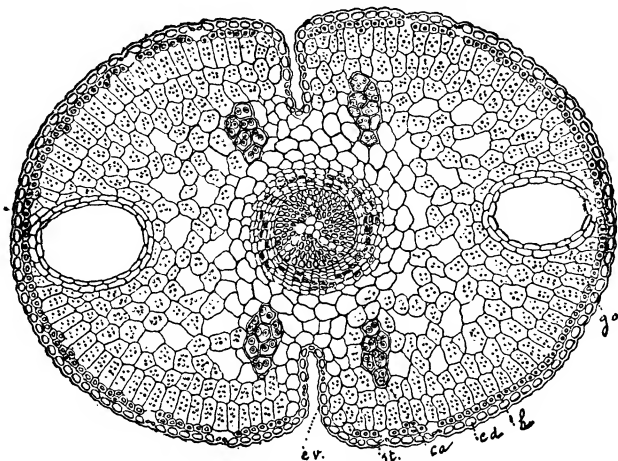


FIG. 36.—Transverse section of twig of *Juniperus Sabina*. *ca*, cells with bordered pits; *ed*, epidermis of lower surface of adnate leaf; *ev*, epidermis of upper surface; *go*, oil gland; *h*, hypodermis; *st*, sunken stoma. (From Greenish's "Microscopical Examination of Foods and Drugs," after Collin, J. A Churchill, London.)

(1) The tops of *Juniperus Phœnicea* which may be distinguished both by the presence of large stone cells in the mesophyll and by the spiral arrangement of the leaves. (2) Tops of *Juniperus thurifera* which possess stone cells in the mesophyll of the leaves, although resembling Savin in having opposite and decussate leaves.

**Allied Plant.**—*Juniperus virginiana* or Eastern Red Cedar is a shrub or tree of pyramidal form and of wide distribution in the United States. Its leaves are scale-shaped and its galbulus fruits purplish. Its wood is widely employed in the form of chips as an insect repellent and is also used in the manufacture of cedar chests and pencils. It is also the source of a volatile oil called "*cedar-wood oil*" which is a valuable clearing agent in microscopy.

#### THUJA (THUJA)

**Synonyms.**—Arbor Vitæ, American Arbor Vitæ; *Ger. Lebensbaum*.

**Botanical Origin.**—*Thuja occidentalis* Linné.

**Part Used.**—The recently dried leafy young twigs.

**Habitat.**—In low swampy localities and along streams from Southern Labrador west to Manitoba, south to North Carolina and Tennessee.

**Commerce.**—The commercial supplies are collected chiefly in North Carolina, Virginia and Michigan.

**Plant.**—A medium sized evergreen tree usually growing to the height of 20 to 50 feet with a tapering, furrowed and buttressed trunk and a dense, conical crown of branches bearing more or less 4-sided twigs that are completely covered by scale-like and closely overlapping leaves. The staminate and pistillate cones occur on different twigs in April and May, the staminate being small, rounded, and yellow, the pistillate small, ovoid and purplish. The fruit is a short, oblong, reddish-brown cone with from 6 to 12 thin, oblong and obtuse scales; each supporting a narrow winged seed.

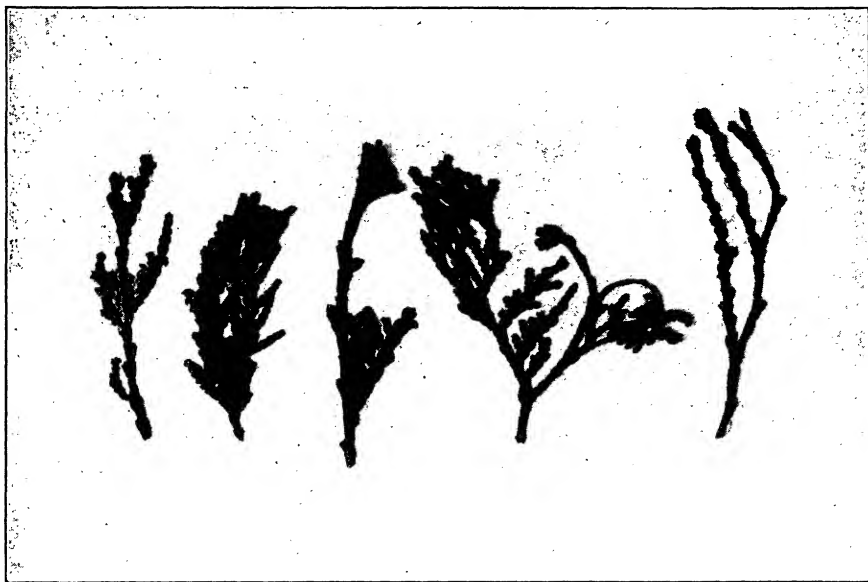


FIG. 37.—Leafy twigs of the Arbor Vitæ, *Thuja occidentalis*,  $\times \frac{1}{2}$ .

**Description.**—Twigs entire or broken, fan-shaped, flattened, bearing 4 rows of appressed, scale-like leaves, all bearing glands on back; odor balsamic, aromatic; taste camphoraceous, turpentine-like and bitter.

**Powdered Drug.**—Greenish to brownish-green. Fragments of chlorenchyma; fragments of *epidermis with broadly elliptical stomata from 25 to 40 $\mu$  in length, the guard cells having lignified walls*; numerous thick-walled lignified fibers with simple oblique pores.

**Constituents.**—Volatile oil containing *pinene*, *fenchone* and *thujone*; a bitter principle termed pinipicrin, a crystallizable coloring principle called thujin, tannin, resin, etc.

**Uses.**—Uterine stimulant, emmenagogue, diuretic, vermifuge and local irritant.

**Average Dose**, 2 Gm. (30 grains).

**Cedar Leaf Oil** (*Oleum Cedrii Folii*) U.S.P., also known as *Thuja Oil* and *Arbor Vitæ Oil*, is the volatile oil distilled with steam from the fresh leafy twigs of *Thuja occidentalis* (Fam. *Pinaceæ*). It is a colorless or yellow liquid with an arbor vitæ odor; sp. gr., 0.910 to 0.920; opt. rot.  $-10^{\circ}$  to  $-13^{\circ}$ ; ref. ind., 1.4560

to 1.4590 at 20°C. It is produced in New York and Vermont. It is used as a perfume substitute for lavender oil in Soft Soap Liniment; also as an insect repellent. It contains not less than 60 per cent of ketones, calculated as *thujone*.

#### JUNIPER TAR U.S.P. (PIX JUNIPERI)

**Synonyms.**—*Oleum Cadinum*, Oil of Cade, *Cade Oil*, *Oleum Juniperi Empyreumaticum*, Oil of Juniper Tar; *Ger.* Kadeöl; *Fr.* Huile de Cade.

**Botanical Origin.**—*Juniperus Oxycedrus* Linné.

**Part Used.**—The empyreumatic volatile oil obtained from the woody portions.

**Habitat.**—Southern Europe and North Africa.

**Plant.**—A tree growing to the height of about 12 ft. with lanceolate to awl-shaped leaves having 2 white lines on their upper surface and chestnut-brown or reddish, globular (galbulus) fruits.

**Description.**—A dark-brown, clear, thick fluid with a tarry odor and a warm, slightly aromatic, bitter and acrid taste.

**Constituents.**—A sesquiterpene called *cadinene*; *phenols*, *guaiacol*, *cresol*, acetic acid, etc.

**Uses.**—Parasiticide in skin diseases, including chronic eczema, psoriasis, favus, etc. usually as an ingredient of an ointment or petroxolin.

**Adulterants.**—Rosin, rosin oils and oil of pine tar.

**Preparation.**—Compound Sulfur Ointment, N.F. (Hebra's Itch Ointment), Compound Soft Soap Liniment, N.F.

#### DWARF PINE NEEDLE OIL N.F. (OLEUM PINI PUMILIONIS)

**Synonyms.**—*Pine Needle Oil*, Swiss Mountain Pine Oil, Dwarf Pine Oil; *Ger.* Krummholzöl.

**Botanical Origin.**—*Pinus Mugo* Turra. (*Pinus Pumilio* Haenke).

**Part Used.**—The volatile oil distilled with steam from the fresh leaves.

**Standard of Assay.**—Not less than 3 per cent and not more than 10 per cent of esters calculated as bornyl acetate ( $C_{10}H_{17}.C_2H_3O_2$ ).

**Habitat.**—Mountains of Central Europe.

**Plant.**—A pyramidal tree with needles up to 2 in. long in fascicles of 2, and conic-ovate cones.

**Commercial Source.**—The Tyrol, in southern France.

**Description.**—A colorless to light amber liquid having a fragrant pinaceous odor and a bitter, pungent taste; sp. gr. 0.925 to 0.937 at 25°C.; ref. ind. 1.4810 to 1.4840 at 20°C.

**Constituents.**—*Bornyl acetate*, *l-pinene*, *l-phellandrene*, *cadinene* and *sylvestrene*.

**Uses.**—Stimulating expectorant and antiseptic in chronic bronchitis, usually in inhalants but also orally; stimulant in chronic rheumatism, also as an ingredient of nasal oils.

**Preparation.**—Ephedrine Sulfate Jelly (Gelatum Ephedrinæ Sulfatis) N.F. (Ephedrine Jelly).

**Allied Drug.**—Oil of Siberian Fir is a volatile oil distilled from the fresh leaves of *Abies sibirica* Ledeb., an evergreen tree indigenous to Russia and Siberia. It contains up to 40 per cent. of bornyl esters and is used for the same general purposes as oil of dwarf pine needles.

## SUBDIVISION II.—ANGIOSPERMÆ OR ANGIOSPERMS

(Plants with covered seeds)

### CLASS A.—MONOCOTYLEDONEÆ

A class of Angiosperms characterized by the following peculiarities:

One cotyledon or seed leaf in the embryo.

Stems endogenous with closed collateral or concentric fibro-vascular bundles, which are scattered.

Leaves generally parallel veined.

Flowers trimerous (having the parts of each whorl in threes or multiples thereof).

Secondary growth in roots generally absent.

Medullary rays generally absent.

### GRAMINEÆ (GRASS FAMILY)

Mostly herbs with cylindric, hollow, jointed stems whose nodes are swollen. The leaves are alternate, with long split sheaths and a ligule. The flowers are generally hermaphroditic and borne in spikelets arranged upon either a compound spike, a raceme or a panicle. The axis of the spikelet is called a rachilla. The lowest floral leaves of each spikelet are called glumes, which are empty and paired. The succeeding floral leaves of the spikelet are bract-like, each supporting one flower in its axil and are called lemmas, outer palets or flowering glumes. Each flower has an inner palet, 2 lodicules, 3 stamens and a single pistil with a 1-celled ovary and 2 feathery styles. Fruit, a caryopsis or grain. Embryo with scutellum. Seeds, albuminous. Seed coat fused with fruit coat to form one layer.

### SUCROSE U.S.P. (SUCROSUM)

**Synonyms.**—*Saccharum*, Sugar, Cane Sugar, Refined Sugar, Beet Sugar. *Ger.* Zucker; *Fr.* Sucre.

**Botanical Origin.**—*Saccharum officinarum* Linné, *Beta vulgaris* L. (Fam. *Chenopodiaceæ*), and other sources.

**Part Used.**—A sugar [C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>].

**Habitat.**—The original home of the cane sugar plant is unknown but is thought to have been India. Widely cultivated in the tropics and subtropics. *Beta maritima* or the "sea beet" is native to the southern coast of Europe. It is the progenitor of the sugar beet, *Beta vulgaris*.

**Plant.**—*Saccharum officinarum* or the Sugar Cane is a perennial herb with a succulent rhizome from which arises a number of solid, jointed, glaucous stems attaining a height of about 6 to 15 feet and a diameter of from about 1 to 2 inches. The leaves are alternate, lanceolate, acuminate, denticulate, glabrous, and clasping, with a white midrib. The pinkish flowers are borne in loose panicles of spikelets. There are several varieties differing in color of stem, height, length of internodes, etc.

**Production and Commerce.**—The sugar cane is cultivated in southern Louisiana and adjacent Texas, in India, Cuba, Java, the Philippines, Puerto Rico, Hawaii, Argentine and other tropical and subtropical countries. It is propagated from stem cuttings (rattoons) or entire stems. The leaves are stripped from the canes and the canes shredded by revolving spiked cylinders and afterwards passed between rollers which press out the juice. As the juice flows from the rollers it is turbid due to contained impurities. It is strained, milk of lime added and then heated with steam. The impurities unite with the lime forming the scum at the top and the sediment at the bottom of the clear purified, sugar solution. The purified juice is conducted to vacuum evaporator pans where it is concentrated and from these to tanks where it is allowed to crystallize. When crystallization is complete, the mixture of crystals and syrup (molasses) is run into centrifugals and the sugar crystals separated from the molasses by centrifugal action. The sugar crystals are then dried.

Additional sources of sucrose are the sugar beet (*Beta vulgaris* L.), a member of the *Chenopodiaceæ* and widely cultivated as the second largest source of sugar especially in the western United States and in Germany, the Chinese sugar cane or *Sorghum vulgare* var. *saccharatum*, the sugar maple (*Acer saccharum*) and the cornstalks (*Zea Mays*).

**Description.**—Sucrose occurs as colorless or white, hard, dry crystals, crystalline masses, or blocks, or as a white crystalline powder. It is odorless and has a sweet taste. One Gm. is soluble in 0.5 cc. of water and in 170 cc. of alcohol.

**Uses.**—Sucrose is a nutrient, diuretic and food preservative. It is used in pharmacy to mask the taste of certain medicines, to preserve pharmaceutical preparations and give them consistency, to prevent oxidation in iron preparations and to make oils miscible with water. It is used in the preparation of Syrup U.S.P., and is an ingredient in troches, syrups, confections and a number of pills, powders and mixtures.

#### TRITICUM N.F. (TRITICUM)

**Synonyms.**—*Couch Grass*, *Dog Grass*, *Quack Grass*, *Witch Grass*, *Twitch Grass*; *Ger.* Queckenwurzels; *Fr.* Chiendent officinal.

**Botanical Origin.**—*Agropyron repens* (Linné) Beauvois.

**Parts Used.**—The dried rhizome and roots, gathered in the spring.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter and not more than 3 per cent. of acid-insoluble ash.

**Habitat.**—In fields and along roadsides of Europe and Asia. Naturalized in North America.

**Plant.**—A perennial weed, the underground portion of which consists of a very long, slender, many-jointed rhizome from which numerous fibrous rootlets emanate from the nodes and by means of which the plant is extensively propagated. The aerial portion consists of a leafy simple culm attaining the height



FIG. 38.—*Agropyron repens* (Couch Grass). Plant.

of 1 m. and bearing a terminal spike of numerous spikelets. Each spikelet is 3-7, usually 5-flowered, the glumes being 8-10 mm. long, 5-7 nerved, acuminate or awn-pointed, the lemmas, about 1 cm. long, strongly nerved, acute or terminating in an awn.

**Commercial.**—Most of the drug is collected in Central Europe. The rhizomes and roots are gathered in the spring and autumn, usually cut into segments varying from 4-12 mm. in length and carefully dried. Some samples which were shipped from Europe consisted entirely of the rhizome of *Cynodon*



*Dactylon*, another grass, which somewhat resembles the genuine article. The commercial supplies of *Triticum* have usually been imported from Belgium, Yugoslavia, Germany, and England. More recently the drug has been collected in considerable amounts in this country, especially in Michigan.

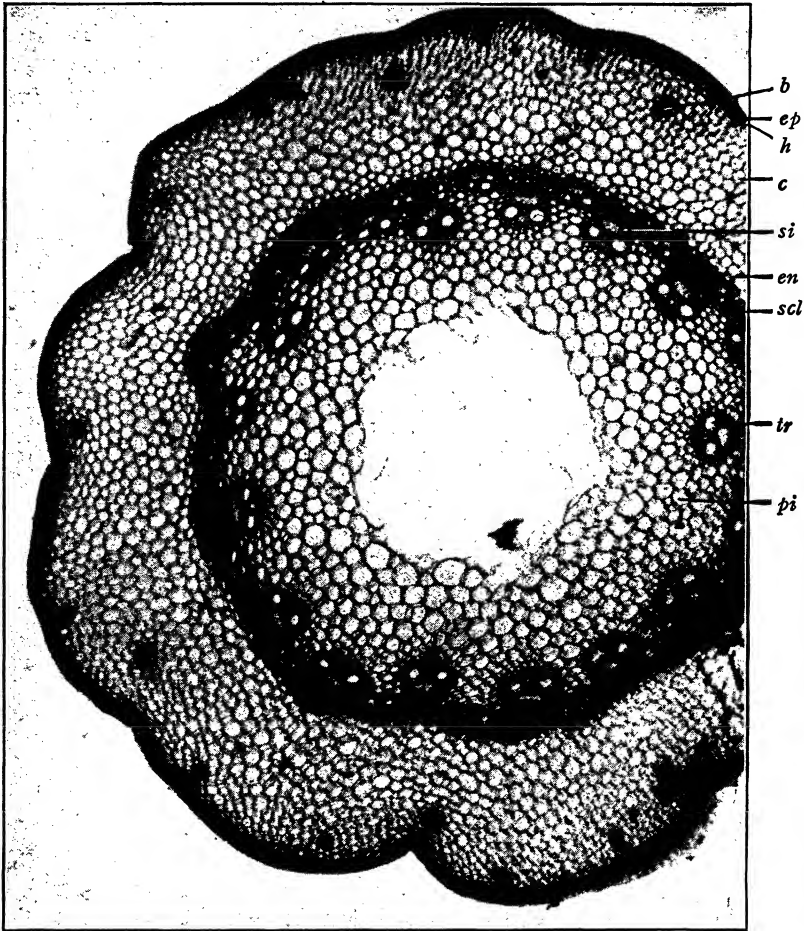


FIG. 39.—Transverse section through rhizome of *Agropyron repens* (*Triticum*). Epidermis (*ep*); hypodermis (*h*); cortex (*c*); sclerenchymatous ring (*scl*); pith (*pi*); endodermis (*en*); sieve tubes of a closed collateral bundle (*si*); trachea of a closed collateral bundle (*tr*); a concentric bundle of the cortex (*b*). Note bundles of pith attached to sclerenchymatous ring.

**Description.**—The drug occurs on the market either in bundles of folded entire and broken pieces attaining a length of 40 cm., as shredded rhizomes, or, more generally, in segments 4–12 mm. long and 1–2.5 mm. in diameter; externally light yellowish brown to moderate yellow, sometimes with darker nodes, smooth and lustrous, showing longitudinal furrows and nodes having circular scars from aerial stems that have fallen off, and root scars as well as occasional filiform rootlets. The fracture is tough, irregular and fibrous. The cut ends exhibit a lemon-yellow color and hollow pith. Odor indistinct. Taste sweet.

**Microscopical Characteristics.**—Cross sections of the *rhizome* present the following characteristics:

1. *Epidermis* of a single layer of cells having lignified walls.
2. *Hypodermis* consisting of 3 to 6 layers of more or less polygonal cells with strongly lignified walls.

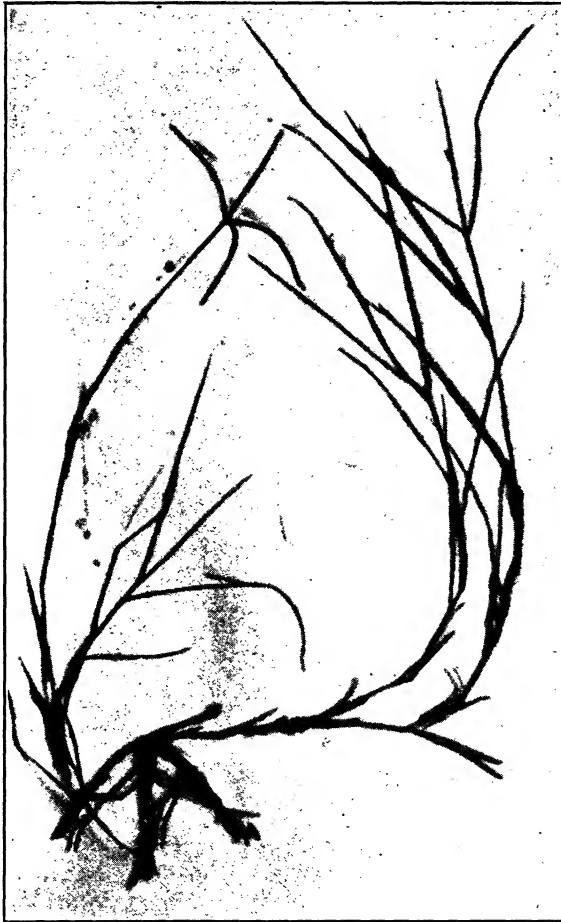


FIG. 40.—*Cynodon Dactylon* (Bermuda Grass). Plant.

3. *Cortex* of up to 16 layers of thin-walled parenchyma cells occasionally with carbohydrate contents either in irregular masses, or, rarely, small spheroidal starch grains. A number of small, widely separated, concentric fibrovascular bundles occur in the region near the hypodermis. Each is surrounded by a closed sheath of sclerenchyma fibers.

4. *Endodermis*, a layer of endodermal cells whose radial and inner walls are porous, thick and strongly lignified.

5. A *Sclerenchymatous Ring* of several rows of sclerenchyma fibers in which are imbedded an irregular, interrupted circle of closed collateral fibrovascular bundles.

6. *Pith*, composed of about 8 or 10 rows of thin-walled parenchyma cells containing a few fibrovascular bundles, most of which are found bordering on and partially surrounded by the inner portion of the sclerenchymatous ring. In the center of the pith region is a hollow space of irregular outline, due to a disintegration of the medullary cells.

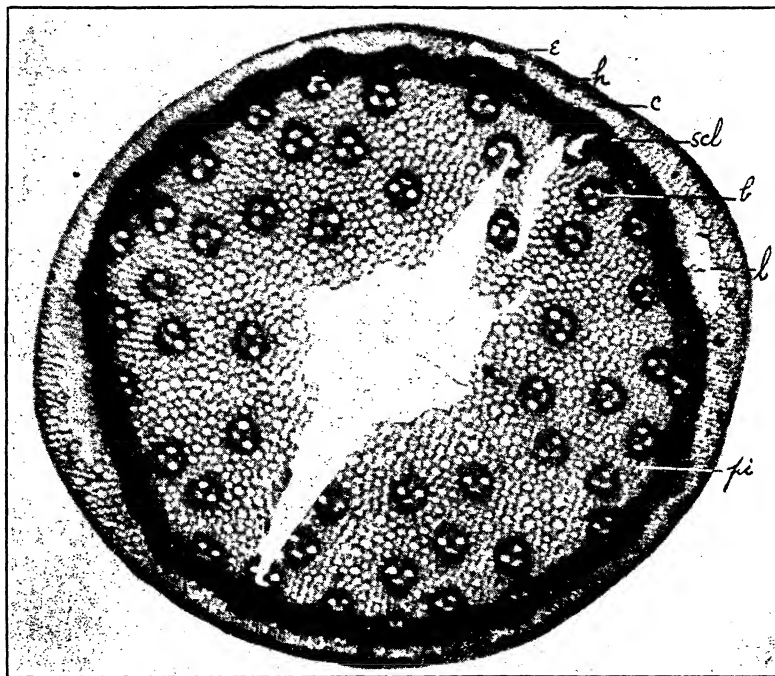


FIG. 41.—Transverse section of Bermuda Grass (*Cynodon Dactylon*) rhizome showing epidermis (e); hypodermis (h); cortex (c); sclerenchyma sheath (scl); fibrovascular bundle (b); pith parenchyma (pi) and lacuna (l).

Surface sections of the epidermis show sinuous-walled, elongated epidermal cells and small twin-cells having strongly silicified walls and of a ball and socket appearance.

**Powdered Drug.**—Weak yellow to weak yellowish-orange; odor slight, aromatic. Numerous irregular fragments of tissues including fragments of *thin-walled, lignified, sclerenchyma fibers associated with portions of annular, spiral or porous tracheæ*, fragments of *rectangular shaped epidermal cells* whose longer, radial walls are porous and lignified, the outer wall silicified, numerous fragments of thin-walled parenchyma cells, and of masses of sclerenchyma fibers.

**Constituents.**—Two glucosides, one yielding vanillin on hydrolysis, a carbohydrate resembling inulin called *tritacin*, dextrose, levulose, mannite, inosite, gum, malates, etc.

**Uses.**—Triticum is employed as a demulcent diuretic in the treatment of cystitis and other catarrhal diseases of the genito-urinary tract.

**Average dose,** 10 Gm. ( $2\frac{1}{2}$  drachms).

**Preparation.**—Triticum Fluidextract, 10 cc. ( $2\frac{1}{2}$  fl. dr.).

**Substitutes and Adulterants.**—(1) The most common adulterant or substitute of Triticum is the dried rhizome and roots of *Cynodon Dactylon* Pers. [*Capriola Dactylon* (L) Kuntze], known to the trade as "Bermuda Grass." The important gross and microscopic differences between the official and spurious rhizomes may be tabulated as follows:

TRITICUM RHIZOME	BERMUDA GRASS RHIZOME
Seldom more than 2 mm. in diameter.	Usually 3 mm. or more in diameter, seldom less than 2 mm.
Soft and pliable.	Hard and brittle.
Sweetish taste.	Somewhat starchy taste.
Outline of cross section—irregularly rounded.	Outline of cross section—somewhat oval.
Cortex comparatively broad and containing 6 to 7 or more fibrovascular bundles.	Cortex only about one-fourth as broad as Triticum and containing 1 or 2 fibrovascular bundles.
Endodermis with inner and radial cell walls considerably thickened.	No characteristic endodermis.
Parenchyma cells of cortex and pith with comparatively thin walls and usually containing no starch.	Parenchyma cells of cortex and pith with comparatively thick walls and containing numerous starch grains.
Pith comparatively narrow and containing only about 10 to 19 fibrovascular bundles, most of which are attached to the sclerenchymatous ring.	Pith comparatively broad and containing 30 to 35 fibrovascular bundles.

(2) Rhizomes and roots of species of *Carex*.

#### WHEAT (TRITICUM SATIVUM)

**Synonyms.**—Common Wheat; *Ger.* Weizen, *Fr.* Blé.

**Botanical Origin.**—*Triticum aestivum* L. (*T. sativum* Lam.; *T. vulgare* Vill.).

**Part Used.**—The grain of several cultivated varieties, separated from the chaff by threshing.

**Habitat.**—Western Asia.

**Plant.**—Wheat is an annual with a fibrous root system and, through tillering, erect stems (*culms*) 2 to 4 ft. in height, each with usually six internodes having a compound spike on its end. The leaves are alternate with lanceolate, grass-like blades, split sheaths, and thin, transparent ligules. The inflorescence is a compound spike consisting of a zigzag rachis bearing averagely 15 to 20 fertile spikelets (one spikelet at each joint). Each spikelet consists of an axis (*rachilla*) bearing 3 to 9 flowers, one or more being sterile and not more than two producing fruit. The glumes are broad. The fruit is an ovate or blunt, spindle-shaped caryopsis. Wheat is a variable plant and occurs in several races and many varieties, which differ in habit of growth, presence or absence of beards, and also in the form, size and shape of the grain.

**History.**—Wheat has been cultivated since remote antiquity as the main cereal food of the Caucasian race. The various varieties and races of this cereal grown today represent modifications, through cultivation, selection, and mutation, of the primitive ancestor. A form of Emmer, *Triticum dicoccum* var. *dicoccoides*, a form with a fragile rachis growing wild at high altitudes in Syria, is believed by Chodat to represent the primitive type of wheat.

**Production.**—Wheat is grown in the temperate regions of North and South America, Europe and Australia. In the colder countries it is planted in the spring and is therefore commonly called "Spring Wheat," whereas in warmer countries it is planted in the fall but makes its chief growth the following season and is known as "Winter Wheat." It is largely grown for making bread flour. After the aerial part of the plant is harvested, it is *threshed* and the "kernel" or naked grain readily separates from the chaff (glumes, paleæ, etc.). The kernels are *cleaned* and *scoured* to remove straw, dust particles, and some of the hairs of the beard. They are then *tempered* by slightly moistening with water to prevent the fruit wall from powdering. By the process of *breaking*, the bran coats and embryo are next separated from the endosperm by passing the grain through successive pairs of iron rolls. The product of each pair of rolls is now *sifted* and the particles graded by size, the coarse particles passing on to the next set of rolls. In due course, the pericarp is separated from the adherent endosperm. The separated pericarp, spermoderm, and perisperm layers together with most of the aleurone layer and a little adherent starchy endosperm constitute the brown flakes or *wheat bran*, a by-product in the manufacture of flour. The finely ground parts of the endosperm are sifted and bolted through silk bolting cloth, the particles which pass through the bolting cloth constituting the *wheat flour*. The coarser granular particles remaining behind constitute the *wheat middlings*. Sometimes the middlings are freed of bran and reground and resifted, the finer products yielding flour, the coarser, *farina*. The flour represents about 70 to 75 per cent. of the grain used. It has been estimated that it takes  $4\frac{1}{2}$  bushels of wheat grains to produce 1 barrel (196 lbs.) of flour. From 25 to 30 per cent. of the grain is processed as farina, middlings, and bran. The chief centers of milling in the U.S.A. are Minneapolis, St. Paul, Kansas City and St. Louis. Between seven and nine hundred million bushels of wheat are grown in this country annually. The principal countries producing wheat are United States, U.S.S. Russia, Canada, France, India, Italy, Germany, and Australia.

**Description.**—Bread Wheat occurs as naked grains ("*naked wheat*") devoid of the glumes, lemma and palea; externally light yellowish brown, ovate to spindle-shaped with rounded or blunt ends, the apex showing a "*beard*" or tuft of hairs; the dorsal side slightly keeled and with a depression near the base marking the position of the embryo, the ventral side with a deep longitudinal groove. When the grain is cut transversely through the central region, the transverse section is cordate with a groove of the ventral side extending to about the center of the grain; the internal surface of the grain is white and starchy.

**Histology.**—*Median longitudinal sections* cut through the groove of a grain of wheat which has been macerated in water for several hours or longer show the following structures, when examined under low power magnification: (1) an outer *pericarp* with a tuft of hairs at the summit fused with (2) the *spermoderm* or seed coat, (3) the *perisperm*, (4) a broad zone of *endosperm* with a single outer layer of *aleurone cells* surrounding the many layers of *starchy endosperm* which comprise the greatest area of the grain. Beneath the endosperm and extending from the base to about one-third the length of the grain will be noted the *germ* or *embryo* consisting of a shield-shaped *scutellum* adjacent to the endosperm which represents a part of the cotyledon beneath which will be noted the *plumule* covered by the *coleoptile* or plumule sheath, the *hypocotyl* and a *radicle* surrounded by the *coleorrhiza* or radicle sheath. The *funiculus* or fruit stalk will be evident as a short stumpy basal structure, with the *micro-pyle* opposite it. Under high power magnification it will be observed that the side of the scutellum next to the endosperm shows a *hyaline* layer of compressed cells, beneath which is a layer of palisade cells, also that the cells of the radicle, plumule and coleoptile are quadrangular.

*Transverse sections* cut through the central part of the grain above the embryo show the following:

**Structures.**—1. **Pericarp**, composed of epicarp, mesocarp and endocarp.

*Epicarp*, of colorless cells, elongated and arranged end to end and with the lateral and end walls distinctly beaded. In sections cut through the apex of the grain, these cells are nearly isodiametric and numerous hairs arise between them. The hairs are up to 1 mm. long, showing a narrow lumen and the walls usually thicker than the width of the lumen.

*Mesocarp*, consisting of an outer region just beneath the epicarp composed of two or three layers of cells somewhat similar to those of the epicarp but with thinner walls and many are more or less collapsed. Within this hypodermal layer is a narrow zone of cells that are thin-walled and with intercellular-air-spaces.

The inner region of the mesocarp is composed of rather thick-walled, transversely elongated cells with distinctly porous radial walls. These cells, known as "*cross cells*," are arranged side by side in rows and show no intercellular-air-spaces.

*Endocarp*, composed of more or less detached or isolated tubular cells which are arranged parallel to the long axis of the grain and therefore at right angles to the cross cells so that in transverse sections of the grain the end walls of the cells are seen. In surface sections these cells are seen to be vermiform in shape so that, when two of the cells are in loose contact, circular intercellular spaces often are formed by the adjacent diverging bends of the cells. These sinuous tubular cells are known as "*tube cells*."

2. **Seed.**—*Spermoderm.*—The seed coat is composed of two layers of elongated cells arranged at right angles to each other or crossing diagonally to the axis of the grain. The outer layer is light colored and the inner layer is dark brown. These appear as light and dark lines in cross sections.

*Perisperm*, a colorless, almost structureless band of cells, marks the remains of the nucellus tissue.

*Endosperm*.—Within the hyaline layer of perisperm is a layer of cells containing proteids. These are the "*aleurone cells*." In transverse section these cells appear square to rectangular and comparatively thick-walled.

The remainder of a transverse section cut through the grain above the embryo region is composed of large thin-walled, isodiametric cells with starch contents. The starch grains occur in two forms, large lenticular to circular grains which average about 30 to 40 $\mu$  and are occasionally up to 50 $\mu$  in diameter, and small rounded or polygonal forms which range in size from very minute grains up to 8 or 10 $\mu$  in diameter.

*Longitudinal Sections*.—When the outer tissues are scraped from a macerated grain, warmed in 1 to 2 per cent. NaOH or KOH solution and mounted in water, the lengthwise or surface view of the elements will be noted. (See Fig. 42.)

1. The *epicarp cells* are longitudinally elongated over the body of the grain and have thick, beaded walls. At the apex they are polygonal with beaded walls and between many of them will be seen unicellular hairs up to about 1 mm. in length. The hairs have a broad base and taper to the end where they are pointed. The thickness of the wall exceeds the width of the lumen.

2. The *mesocarp cells* in the outer layer resemble those of the epicarp except for the absence of hairs. The inner layers, however, have thinner walls and air-spaces may be seen between some of their cells.

3. The *cross cells*, arranged in parallel rows with thick, beaded walls except on their ends and are transversely-elongated, at right angles to the layers without. No intercellular-air-spaces occur between their end (radial) walls.

4. The sinuous *tube cells* of the endocarp, both isolated and in loose contact, arranged at right angles to the cross cells.

5. The *spermoderm cells*, especially those of the inner layer which are dark brown and cross the outer light brown layer.

6. The *perisperm*, a sheet of transparent tissue which takes a blue color with chlor-zinc iodine solution.

7. The *aleurone cells* which are mostly rounded-polygonal, with thick colorless walls and dark yellow contents consisting of protein granules, fat globules and a prominent nucleus.

8. The *starchy endosperm cells*, isodiametric in the outer layer or two and radially elongated with comparatively thin walls. Swollen starch and gluten may be seen in some of the cells which have not been completely cleared.

*Allied Cereals*.—*Durum*- or *macaroni wheat* represents the naked grain of *Triticum durum* Desf. It is a hard, horny or flinty wheat type with an endosperm completely horny in character and rich in protein. Flour made from it is used in the preparation of macaroni, spaghetti and other edible pastes.

*Polish wheat* represents the naked grain of *Triticum polonicum* L., a native of Eastern Europe. It is likewise a hard wheat.

*Spelt*, *Emmer* and *Einkorn* are types of chaffy wheats, the lemma and palet

not being separated from the fruit in threshing. Spelt is yielded by *Triticum Spelta* L. and Emmer by *Triticum dicoccum* Schrank. Einkorn represents the grain of *Triticum monococcum* L.

**Constituents.**—Proteins (8 to 20 per cent.), Vitamins A, B<sub>1</sub>, B<sub>2</sub> and E, fat (0.28 to 2.5 per cent.), starch (53 to 63 per cent.), a rubbery substance called gluten, sucrose, lecithin, pentosans, nucleic acid, phytin (inosite hexaphosphoric acid), the enzymes amylase, phytase, protease, lipase, maltase, tyrosinase, peroxidase and oxalase; ash, etc.

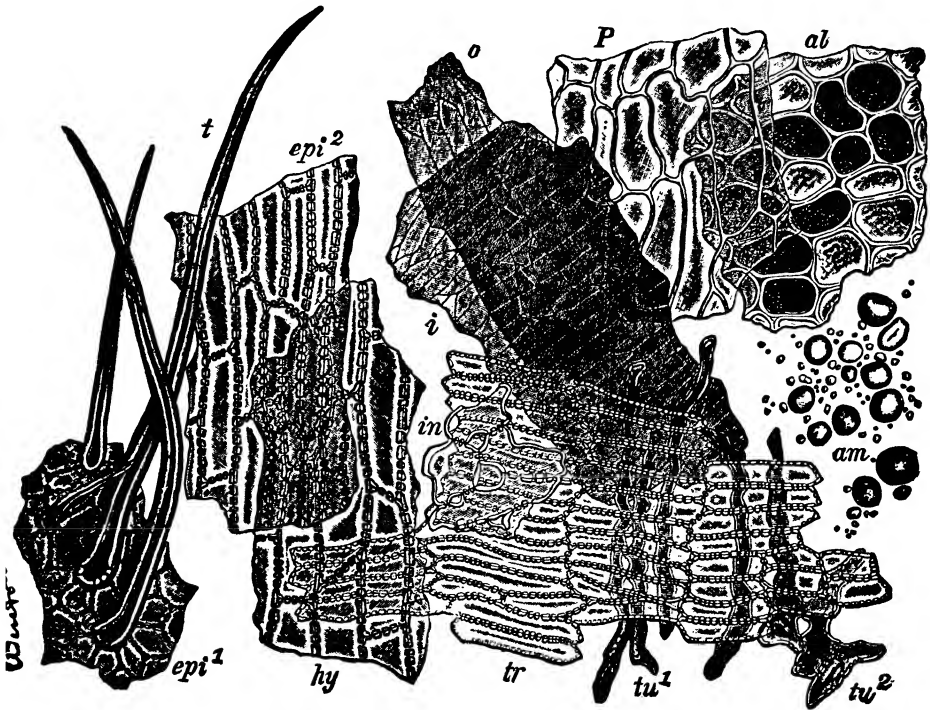


FIG. 42.—Wheat. Surface view of bran tissues. *epi<sup>1</sup>*, Epicarp with hairs (*i*) at apex of naked grain; *epi<sup>2</sup>*, Epicarp on body of naked grain; *hy*, hypodermal layer of mesocarp; *in*, intermediate cells; *tr*, cross cells; *tu<sup>1</sup>* and *tu<sup>2</sup>*, tube cells; *o*, outer and *i*, inner spermoderm; *P*, perisperm; *al*, aleurone cells; *am*, starch grains.  $\times 160$ . (After Winton, *Structure and Composition of Foods*, vol. I, J. Wiley & Sons.)

**Wheat Products.**—Roasted Whole Wheat has been employed as a coffee adulterant.

**Graham Flour**, obtained by grinding the entire naked wheat grain. It shows the same microscopical elements as the grain.

**Cooked Whole Wheat** including rolled wheat breakfast foods, shredded wheat, puffed wheat, etc. which show characteristic bran tissues and soluble starch.

**Malted Whole Wheat Products** which are steam cooked and malted. These exhibit altered starch grains showing circular striations and fissures.



**Wheat Screenings** consisting of damaged, unripe, or broken grains, and weed seeds. Used as stock feed.

**Wheat Flour**, consisting of the finely ground, sifted and bolted starchy endosperm with some hairs which have passed endwise through the bolting cloth. Under the microscope, water mounts show numerous wheat starch grains, fragments of starch parenchyma, cell walls and an occasional fragment of a unicellular, non-glandular hair. Wheat flour contains more gluten than the flours of other cereals. White or patent wheat flour is devoid of vitamins, but is now being fortified by the addition of thiamin, nicotinic acid and iron.

**Wheat Starch**.—In hard, irregular lumps or as a powder. Under the microscope the starch grains are simple, flattened-circular, lenticular when viewed on their edges, the larger grains 28 to 50 $\mu$  in diameter, the hilum and lamellæ indistinct, except in grains from partially germinated wheat or when treated with diluted alkali or acids when the hilum appears as a central, circular, refractile spot and the lamellæ are concentric; polarization cross indistinct except when viewed on edge.

**Wheat Bran** consists chiefly of the pericarp, spermoderm and perisperm together with most of the aleurone layer and fragments of the adhering starchy endosperm cells. It is used as a roughage and stock food. It contains *Vitamins A, B<sub>1</sub>, and B<sub>2</sub>*.

**Diabetic Wheat Bran** is bran washed free of starch.

**Wheat Middlings** consist of bran tissues, most of the wheat germ and, in some cases varying amounts of starchy endosperm. This product has been one of the main adulterants for powdered drugs and spices. It is also employed as a diluent in veterinary powders and boluses.

**Wheat Germs** represent the embryos of wheat. They contain diagnostic small, quadrilateral cells with protein and fixed oil content, but no starch. Used in some breads and foods. They contain *Vitamins A, B<sub>1</sub>, B<sub>2</sub> and E*.

**Wheat Germ Oil** consists of the pure, cold pressed and refined fixed oil from freshly ground wheat embryos. It contains *Vitamin E*. Wheat Germ Oil and Vitamin E, the latter containing  $\alpha$ -tocopherol and other tocopherols, have been used in threatened abortion and abruptio placentæ.

#### BARLEY (HORDEI FRUCTUS)

**Synonyms**.—*Ger.* Gerste; *Fr.* Orge.

**Definition**.—The grain (caryopsis) of one or more varieties of *Hordeum vulgare* L. (*Hordeum sativum* Jess.) and *Hordeum distichon* L.

The two-rowed barley, *Hordeum distichon* L. [*Hordeum sativum* Jess. var. *distichon* (L.) Hackel], is the type most commonly cultivated in the United States and in central and northern Europe. The barley of Egypt and commonly found in ancient tombs is a six-rowed barley, *Hordeum hexastichon* L. There also occurs a four-rowed barley, the fruit of *Hordeum sativum* Jess. var. *vulgare* (L.) Hackel.

**Habitat.**—Probably western Asia as an evolution from a wild form of barley (*Hordeum spontaneum* Koch).

**Plant.**—Barley is an annual grain attaining a height of from 0.6 to 1 m. The stem is a 5- to 7- or occasionally 8-jointed culm bearing alternate leaves with pronounced auricles.

The inflorescence is a cylindrical, compound spike, up to 10 cm. in length, which consists of a compressed rachis bearing two rows of fan-like groups of spikelets. Each group consisting of three spikelets and the groups of each row alternate on opposite sides of the jointed rachis. Each spikelet is one-flowered and in the two-rowed variety only the middle spikelet is fertile and produces grain. In the six-rowed and four-rowed varieties all three spikelets are fertile but the grains of two lateral spikelets are smaller and less well developed than the grain of the middle spikelet.

Each spikelet has two slender empty glumes, both of which are left on the head in the process of threshing.

The flowering glume and palet closely envelop the kernel and remain attached to it so that barley as it enters commerce is a *chaffy* grain.

**Production and Commerce.**—Pliny recognized barley as the most ancient of foods of the human race. It is now the chief grain grown for malting and brewing. The countries yielding the greatest supply of barley are United States, Russia, India, Germany, Roumania, Japan and Spain. Rough awned and smooth awned varieties are grown in this country, the latter having been introduced from Russia.

The grain is separated by threshing from the straw.

**Description.**—The fruit enveloped by the flowering glume and palet is distinctly spindle-shaped and usually of a buff color. The flowering glume (lemma) is broad, five nerved (ribs), and bears a long awn with barbed edges. The awn is usually broken off during threshing. The palet is two-ridged. Beneath the palet and over the groove of the kernel is the rudiment of the rachilla of an abortive flower, forming a *bristle*. Also present are two minute lodicules which appear downy with hairs. The kernel is usually buff, spindle-shaped and in general structure resembles wheat except that the groove is broad and shallow.

**Histology.**—In the microscopic study of barley it is necessary to consider the chaff (consisting of flowering glume, palet, rachilla, and lodicules) and the denuded caryopsis (*kernel*) tissues.

**Chaff.**—*Lemma* and *Palet*. Both of these structures are similar in their general histology. Both in *cross section* show the following characteristic tissues:

1. *Outer epidermal cells* strongly silicified;
2. *Hypodermal region* of one or two layers of sclerenchyma fibers;
3. *Spongy parenchyma* of irregularly quadrilateral cells and circular to irregular intercellular-air-spaces through which region run occasional fibro-vascular bundles of the ribs;
4. *Inner epidermis* of tangentially-elongated, thin-walled cells and stomata.

*In surface view* the outer epidermal cells are of three forms: (a) elongated wavy-walled cells; (b) twin cells, one of which is crescent-shaped and the other oval or elliptical; (c) small circular cells extending into short, warty or conical

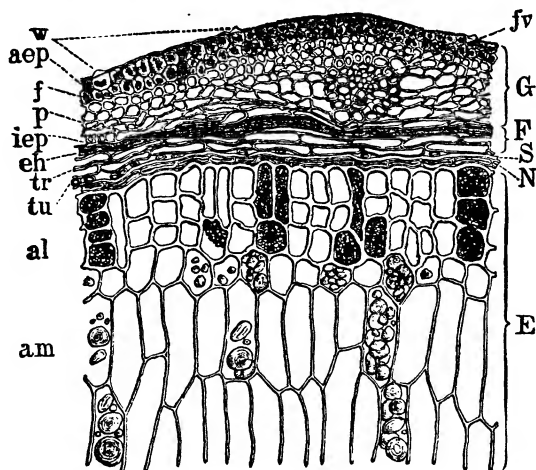


FIG. 43.—*Barley*. Kernel and chaff in median dorsal cross section. G, lemma (flowering glume); aep, outer epidermis with w cuticular warts; f, fiber layer; p, spongy parenchyma with fv, fibro-vascular bundle of nerve; iep, inner epidermis. F, pericarp; eh, epicarp and hypodermis; tr, cross cells; tu, tube cells. S, spermoderm. N, perisperm. E, endosperm; al, aleurone cells; am, starch cells.  $\times 160$ . (From Winton and Winton, "The Structure and Composition of Foods," vol. I, J. Wiley & Sons, Inc.)

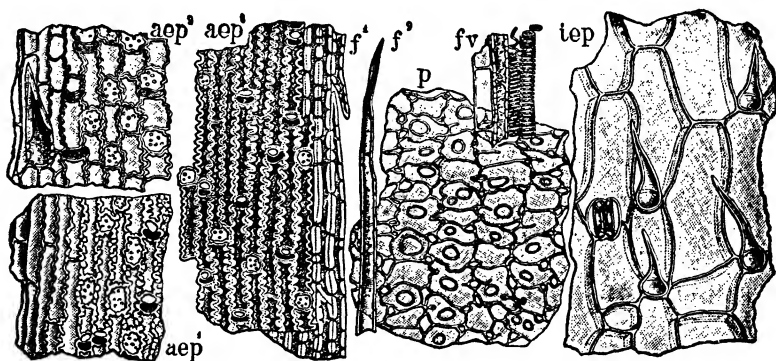


FIG. 44.—*Barley*. Elements of the lemma in surface view. aep¹, outer epidermis at thin margin midway between base and tip; aep², outer epidermis at tip. Tissues over middle of dorsal side of grain: aep³, outer epidermis; f¹, thick-walled fibers; f², thin-walled fiber; fv, fibro-vascular bundle; p, spongy parenchyma; iep, inner epidermis with awl-shaped hairs and stoma.  $\times 160$ . (After Winton and Winton, "The Structure and Composition of Foods," vol. I, J. Wiley & Sons, Inc.)

hairs. The *inner epidermis* shows elongated, thin-walled cells, stomata and short, thin-walled hairs with bulbous bases and attenuated ends.

*Lodicules*.—The chief diagnostic tissue of the lodicules consists of the hairs, ranging up to 1300 microns in length. These hairs vary remarkably in length

and character. The longer hairs have thin walls and the lumen is comparatively wide. The shorter hairs may have branches.

**Rachilla.**—The epidermal cells of the rachilla are similar to those of the lemma and palea. The hairs from the apex of the bristle are extremely stout; up to 60 microns in breadth at the base and with walls up to or over 10 microns in thickness. In length they vary from short forms up to long forms that exceed 1000 microns.

**Fruit.**—(*Pericarp and Seed Regions*).—**A. Pericarp**—consisting of *epicarp*, *hypodermal* layers, *double cross cell* layer, and *endocarp* of tube cells.

In surface view (1) the *epicarp cells* are elongated to polygonal, with rather indistinctly beaded side walls. Most of the *hairs* of the epicarp are less than  $300\mu$  in length and resemble those of wheat (thick walls and narrow lumen); others may be up to 650 microns in length and resemble hairs of rye in that they have thin walls and broad lumens.

2. *Mesocarp or Hypodermal* cells, of two or more layers, similar to the epicarp cells.

3. *Cross Cells.*—There are two layers of these cells and they differ from those of wheat in that the walls are not porous (non-beaded). The walls are scarcely 2 microns in thickness and intercellular spaces occur sparingly between the end walls.

4. *Tube cells* appear as an endodermal layer of detached cells.

**B. Seed.**—*Spermoderm.*—A layer of elongated cells with thin delicate walls. The cells sometimes occur as short rows arranged side by side. In transverse sections this layer appears as a colorless line.

*Perisperm.*—A layer of cells beneath the spermoderm and may be mistaken for a second layer of spermoderm cells. The cells of this layer are shorter, broader, and thicker-walled than the cells of spermoderm. The walls may be more or less wavy as seen in surface sections.

*Endosperm.*—Composed of two regions, aleurone and starchy endosperm. (a) Aleurone region differs from that of all other cereals in being composed of two to four layers of cells whereas in other cereals this region is only one layer of cells thick. In surface view the cells appear rounded or polygonal and are smaller than the aleurone cells of wheat or rye. (b) The starch-parenchyma cells contain large and small starch grains. The larger grains seldom exceed 30 microns in diameter and usually are from 18 to  $25\mu$ . Some of the grains appear bulged on one side and so, sub-reniform, others are flattened-circular to lemon-shaped, elliptical when viewed on edge, but in most other respects they resemble wheat and rye starch grains.

*Embryo.*—In both form and structure it resembles that of other cereals.

**Constituents.**—Proteins (8.5–19 per cent.) including hordein (soluble in alcohol), edestin (soluble in salt solution), an albumin, soluble in water, called leucosin and water insoluble protein; starch 58–59 per cent., fat (0.37–2.5 per cent.) containing oleic, palmitic, stearic, linolic and linolenic acids; pentosans, sucrose, raffinose, lecithin, nucleic acid, phytin, porphyrin, the enzymes protease,

pentosase, diastase, vitamins A and B<sub>1</sub>, etc. Husked barley is devoid of vitamin A.

**Barley Products.**—Barley is chiefly used as a brewing grain. The kernel is used as a food for humans chiefly in the form of "*Pearl barley*" or as a "*Patent barley flour*." *Roasted barley* is used as a coffee substitute.

**Pearl Barley.**—Pearl barley is prepared by so milling as to remove the enveloping chaff and most of the bran, leaving the denuded kernels as rounded grains. Tissues of the pericarp and spermoderm may be found in the groove.

Pearl barley is chiefly used in soups. It may be used as a gruel or for preparation of "*barley water*," the latter often a useful beverage for persons undergoing strenuous labor during hot weather.

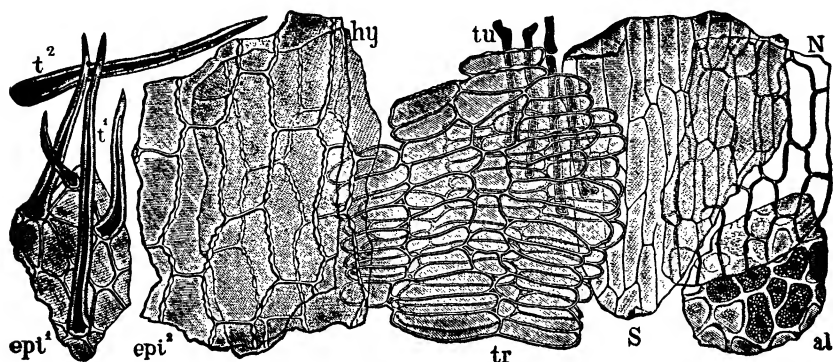


FIG. 45.—*Barley*. Bran coats of grain in surface view. *epi*<sup>1</sup>, epicarp at apex of denuded grain with *t*<sup>1</sup> and *t*<sup>2</sup> hairs. Layers on middle of dorsal side: *epi*<sup>2</sup>, epicarp, *hy*, hypodermis; *tr*, double layer of cross cells; *tu*, tube cells; *S*, spermoderm; *N*, perisperm; *al*, aleurone cells of endosperm. X 160. (From Winton and Winton, "*Structure and Composition of Foods*," J. Wiley & Sons, Inc.)

*Barley Farina* or Grits is a coarsely ground form of Pearl Barley.

*Barley Flour* is a finely ground product of the denuded grain and contains the least possible amounts of chaff and bran tissue. Its most important diagnostic elements are hairs from the epicarp which are shorter than those of wheat, some with walls thicker than lumen and up to 300 $\mu$  long, others with thin walls and broad lumen and up to 650 $\mu$  in length; characteristic non-porous cross cells in 2 layers and starch grains which are flattened-circular, sub-reniform or lenticular to lemon-shaped and up to 30 $\mu$  in diameter. This product is largely used with "milk sugar" for preparing "modified milk" for infants. It is nutritious and easily digested, so useful as a diet for fever patients.

*Malt* is the sprouted and steamed whole barley from which the malt sprouts (radicles) have been removed. See also *Maltum*, p. 147.

*Malt Sprouts.*—The radicles removed in the preparation of *Maltum*, and

*Brewer's Grains*, the by-products from the manufacture of beer, are both used as stock feed, either in the moist unfermented condition, by stock raisers near to the breweries, or after kiln-drying which aids in preventing fermentation so they may be shipped to the distributors.

## MALT (MALTUM)

**Synonyms.**—Barley Malt; *Ger.* Malz, Perlgerste; *Fr.* Orge Perlé, Dreche.

**Botanical Origin.**—One or more varieties of *Hordeum vulgare* L.

**Part Used.**—The grain, partially germinated artificially, and containing amylolytic enzymes.

**Plant.**—(See Barley.)

**Production and Preparation.**—The countries yielding the greatest supply of barley are Russia, United States, India and Germany. Various types exist, some with two rows, others with four or six rows of spikelet groups. The two-rowed barleys are preferred for the preparation of malt in Europe since they have the largest and softest grains. The six-rowed barleys appear to yield most of the malt in this country. The grain is separated from the straw by threshing. In the preparation of malt, barley grains are steeped for from forty-eight to seventy-two hours in water and then spread out on the floor of a malting room, the temperature of which is from 50 to 60°F. Germination is so regulated that when the young shoot begins to make its appearance the grain is slowly dried on the floor at a moderate temperature and later in kilns at from 130° to 160°F. During the process of germination the ferment, diastase, from the epithelial layer of the scutellum, is secreted, which converts starch into maltose and dextrins, a protease converts the proteids into peptones and amino-acids, and the soluble food is translocated to the embryo which sprouts from the grain in the form of 3 to 4 radicles and a short shoot. These are removed. In commerce malt is known by color terms, the color being dependent upon the temperature and time employed in kiln-drying the grains. *Amber malt* is the most esteemed for medicinal purposes. *Black malt* is employed in the manufacture of porter and stout. It should be kept protected from moisture and heat.

**Extract of Malt N.F.** is obtained by infusing malt with water at 60°C., expressing the liquid and concentrating it at not over 60°C., preferably under reduced pressure. The extract may be mixed with 10 per cent, by weight, of glycerin. It contains dextrin, maltose, amylolytic enzymes, and a small amount of glucose. It is capable of converting not less than 5 times its weight of starch into water-soluble sugars.

**Description.**—Barley Malt occurs in entire, yellowish or amber-colored grains, rounded at the base, grooved on one side and acuminate at the apex. The fracture is brittle, exhibiting a nearly white internal surface. The odor is characteristic and the taste sweet.

**Constituents.**—*Diastase*, *invertase*, soluble starch, *maltose*, *lipase*, *protease*, *peptidase*, proteids, soluble proteins, pentosans, lecithin, phosphoric and lactic acids, *vitamin B<sub>1</sub>*, etc.

**Uses.**—Malt is employed medicinally chiefly in the form of its extract for its nutritive properties and as a vehicle for the administration of cod-liver oil, hæmoglobin, cascara sagrada and various salts. Commercially, malt is used in the brewing and distilling industries.

**Preparation.**—Malt Extract (Extractum Malti) N.F., 15 Gm. (4 dr.).

**Diastasum** or **Diastase** (U.S.P. IX) occurs as a yellowish-white amorphous powder or in translucent scales. It represents a mixture containing amylolytic enzymes obtained from an infusion of malt. Digestant. Av. dose, 0.5 Gm.

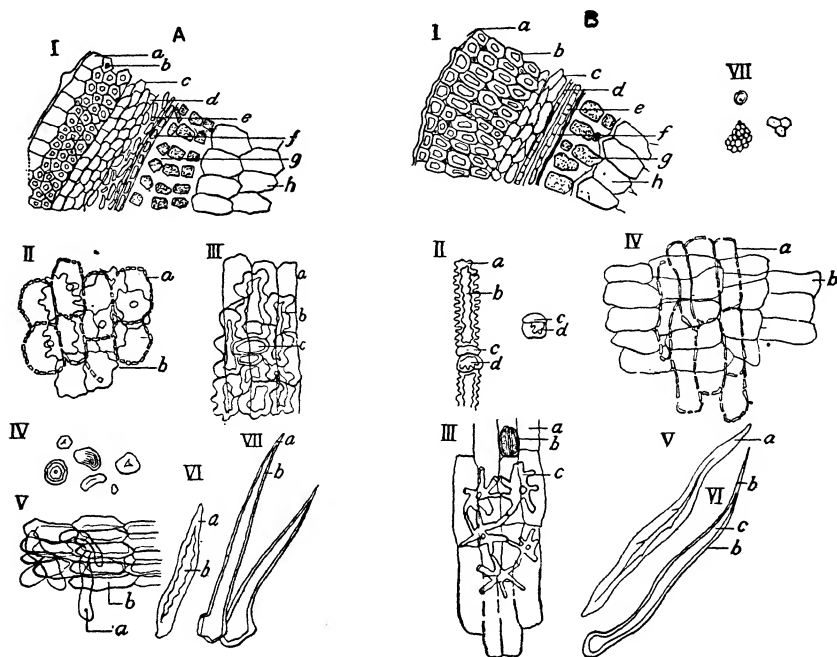


FIG. 46.—A, *Malt*. I. Transverse section through outer portion of grain. Lemma (*a, b, c*); pericarp (*d, e*); spermoderm (*f*); aleurone layers of endosperm (*g*); starchy endosperm (*h*). II. Surface view of epicarp (*a*) and parenchyma of lemma (*b*). III. Surface view of lemma; inner epidermis (*a*), outer epidermis (*b*), and twin cells (*c*). IV. Altered starch. V. Surface section showing 2 layers of cross cells (*b*) and tube cells (*a*). VI. Hypodermal fiber. VII. Hairs from epicarp; apex (*a*) and lumen (*b*). B, *Oats*. I. Transverse section through lemma and outer portion of grain. Lemma (*a, b, c*); pericarp and spermoderm (*d, e, f*); aleurone layer of endosperm (*g*); starchy endosperm (*h*). II. Elements of lemmas and paleas. Cells of outer epidermis in surface view: elongated cells (*a* and *b*); crescent shaped cell (*c*); silica containing cell (*d*). III. Surface view of lemma and palea. Inner epidermis (*a*); stoma (*b*); spongy parenchyma (*c*). IV. Surface view of bran coats. Epicarp (*a*); cross cells (*b*). V. Hypodermal fiber of lemma. VI. Hair from epicarp. Wall (*b*); lumen (*c*). VII. Oat starch.

#### OAT (AVENA)

**Synonyms.**—Cultivated White Oats, Common Oats, Panicle Oats; *Ger.* Hafer; *Fr.* Avoine.

**Botanical Origin.**—*Avena sativa* Linné.

**Part Used.**—The grain.

**Purity Rubric.**—Oat contains not more than 5 per cent. of wild oats and not more than 3 per cent. of foreign organic matter, and yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—Eurasia. Cultivated extensively in temperate zones of both hemispheres.

**Plant.**—An annual herb with bluish-green leaves and a terminal spreading panicle of spikelets. The individual spikelets usually possessing 3 flowers. Subtending each spikelet are two large, membranous, empty glumes. The fruit is an elongated caryopsis (grain) tapered toward both ends.

**Production and Commerce.**—Oat thrives best in wet soil and a moderately cool, humid climate. It is extensively cultivated in the United States which

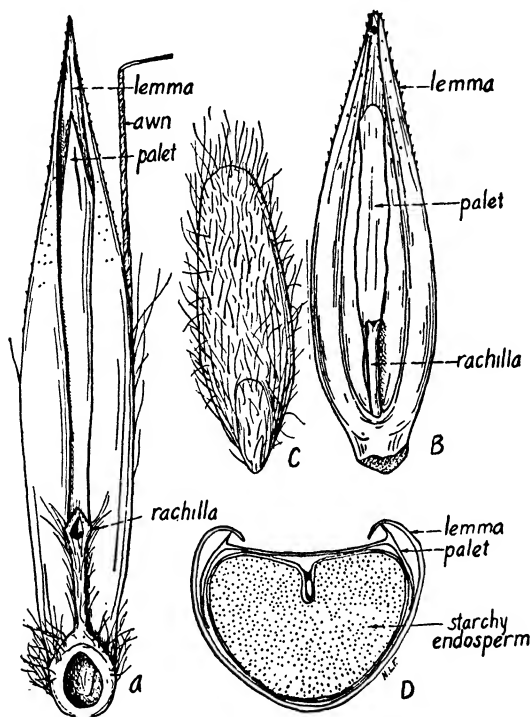


FIG. 47.—Oats. A, mature grain of wild oats (*Avena fatua*); B, mature grain of cultivated oats (*Avena sativa*); C, grain of same with "hull" removed; D, cross section of grain with the "hull." A, B, and C,  $\times 5$ ; D,  $\times 10$ . (After Robbins.)

for years has led the world in the production of this cereal. Russia, Germany, Canada, France, Austria, Great Britain, Sweden and Argentina also produce large annual yields. The mature oat plants are mowed down and carried to the threshing floor where the grains are threshed out, the stems with adhering glumes being separated as straw. The grains are dried on the floors of barns, cleaned and marketed in bags.

**Description.**—Whole oat occurs as a somewhat spindle-shaped, light yellowish-brown to weak greenish-yellow grain, up to 1.5 cm. in length and about 3 mm. broad, enveloped by chaff consisting of a larger scale or *lemma* (flowering glume) and a *palea*. The *lemma* surrounds the grain except on the ventral side where there is a distinct longitudinal groove showing usually a minute



stalk at its base. Its outer surface is smooth and 5 or more veined, showing above the center a scar, or the remains of a straight or slightly twisted awn. Within the groove on the ventral side is a thin, membranous, two-veined *palet*. The fruit or naked grain is tapered toward either end and exhibits a distinct longitudinal groove on its ventral side, at the micropylar end of which occurs a wart-like outgrowth or *caruncle* and at the summit a "beard" of long slender hairs which also occur more sparsely over the remainder of the fruit surface; odor slight; taste starchy. (See Fig. 47.)

**Histology.**—Under the microscope prepared mounts of macerated material of the flowering glume, palet and fruit (surface and transverse sections) exhibit the following structures: (See Fig. 46B.)

**Lemma.**—1. *Outer Epidermis* consisting chiefly of elongated wavy-walled and beaded cells with silicified and lignified walls, between the ends of many of which are crescent-shaped and circular cells, the latter fitting into the concave side of the former and each with greatly silicified walls, and between a few, elliptical stomata. Along and near the margin occur unicellular, non-glandular, dagger-shaped hairs, some being comparatively thick-walled and slightly curved toward their ends, others rigid and thick-walled.

2. *Hypodermis* of from 4 to 10 layers of thick-walled, partially beaded, lignified, taper-ended, sclerenchyma fibers up to 1 mm. in length.

3. *Spongy Parenchyma* consisting of a narrow zone of somewhat star-shaped cells and large intercellular spaces.

4. *Inner Epidermis* composed of elongated, thin-walled cells and elliptical stomata.

**Palet.**—This portion of oat simulates closely the structure of the lemma in its middle region except that the hypodermis is thinner. This region tapers off into membranous wings, in parts of which the hypodermal fibers become entirely wanting and the epidermis with entirely thin walls. Along the margins and keels of the palet are numerous stiff, sharp-pointed, straight or curved, unicellular, non-glandular hairs up to  $250\mu$  in length, while parallel to the keels are rows of elliptical stomata, up to about  $40\mu$  in length.

**Fruit.**—1. *Epicarp* of longitudinally elongated, thin-walled cells, except at apex and base where they are more or less isodiametric. From a number of these arise slender pointed, unicellular, non-glandular hairs, up to 2 mm. in length. Other layers of pericarp and the spermoderm and perisperm of collapsed or poorly defined cells.

2. *Endosperm* consisting of an outer layer of aleurone cells with thin walls, the remainder of the tissue composed of large, thin-walled, parenchyma cells filled with polygonal and spindle-shaped starch grains, the starch grains being frequently gathered in ellipsoidal or rounded aggregates.

3. *Embryo*, forming a broad, spindle-shaped region about 2 mm. in length and found embedded in the endosperm near the micropylar end.

**Powdered Oat.**—Yellowish-white to weak yellow. Fragments of lemma and palet with characteristic tissues; fragments of epicarp with elongated, thin-walled cells up to about  $400\mu$  in length from a number of which arise

slender pointed hairs, up to 2 mm. in length, about  $20\mu$  in diameter at the base, larger in the middle and with lumina up to  $9\mu$  in diameter and walls up to  $8\mu$  in thickness; fragments of endosperm with cells containing ellipsoidal or rounded, many-compound starch grains, the compound grains up to  $60\mu$  in diameter with individual grains polygonal or spindle-shaped and rarely over  $10\mu$  in diameter.

**Constituents.**—Oats are composed of about 70 per cent. kernel and 30 per cent. chaff (husk); the kernel contains *carbohydrates* (67.09 per cent.), *albuminoids* (14.31 per cent.); *fixed oil* (8.14 per cent.), fiber (1.38 per cent.), ash (2.15 per cent.), water (6.93 per cent.); amino-acids, the enzymes amylase, protease, lipase; phytin, *vitamins A (low)*, *B<sub>1</sub>*, *B<sub>2</sub>* and *E*., etc.

**Uses.**—Nutrient and demulcent.

**Average Dose.**—4 Gm. (60 grains).

**Preparations** (unof.).—Fluidextractum Avenæ, 4 cc. (1 fl. dr.); Elixir Hydrastis Comp., 4 cc.

**Adulterants.**—1. *Wild Oat*, the grain of *Avena fatua*, which differs from that of cultivated oat in having the awn of the lemma strongly twisted and in having long reddish-brown hairs at the base of the lemma and on the rachilla. (Fig. 47A.)

2. *False wild oat*, which possesses a long, twisted and bent awn.

**Oat Products.**—*Whole oats* are used as a horse and cattle food.

*Groats* are oat kernels deprived of their husks.

*Oatmeal* and *Rolled Oats* are prepared by removal of the chaff after which the kernels are rolled or ground. Sometimes the kernels are first cut and partially cooked before rolling in order to lessen the time required in preparing the product for the table ("*quick oats*").

*Provender* is a horse food consisting of a mixture of ground oats and corn.

#### MAIZE (INDIAN CORN)

Maize (*Zea Mays* L.) or Indian Corn is a native American cereal plant cultivated by the aborigines long before the arrival of the white man. In the United States it is the most important single crop raised, there being produced here about three billion bushels annually. According to recent evidence, cultivated corn originated from a wild form of pod corn (*Zea Mays* L. var. *tunicata*) which once grew in the lowlands of central South America. It is believed that wild corn from which our modern cultivated corn has originated was similar to plants developed by crossing pop corn with pod corn, producing a type in which smooth hard seeds enclosed in glumes are borne on the branches of the tassel.

Teosinte or *Euchlaena mexicana* Schrad., a tall Mexican grass, closely related to corn and with which corn can readily hybridize, is suspected of being a hybrid of South American corn and Gama grass, *Tripsacum dactyloides* L. The nearest relatives of corn are Teosinte and Gama grass.

**Plant.**—*Zea Mays* L. is an annual monoecious herb with a fibrous root system proceeding from several nodes at the base of the stem, an erect, jointed stem with soft pith in the internodes, and long, flat, lanceolate leaf blades arranged

alternately on opposite sides of the stem, each with a tightly fitting ligule which closely invests the stalk, serving as a rain-guard. The staminate inflorescence consists of a panicle of spikelets at the top of the corn stalk called the tassel. Each normal spikelet bears 2 flowers, each of which has 3 perfect stamens and a rudimentary pistil. The pistillate inflorescence is a close axillary spike, called the "ear" which is borne on a short branch or "shank." The shank consists of a number of nodes and short internodes, the nodes bearing modified leaves in the form of leaf-sheaths, the laminae being aborted. Collectively, the leaf-sheaths on the shank constitute the "husk" of the ear.

**The Corn Ear.**—An ear of corn consists of a thickened rachis or fleshy axis bearing paired, longitudinal rows of female spikelets. Each female spikelet

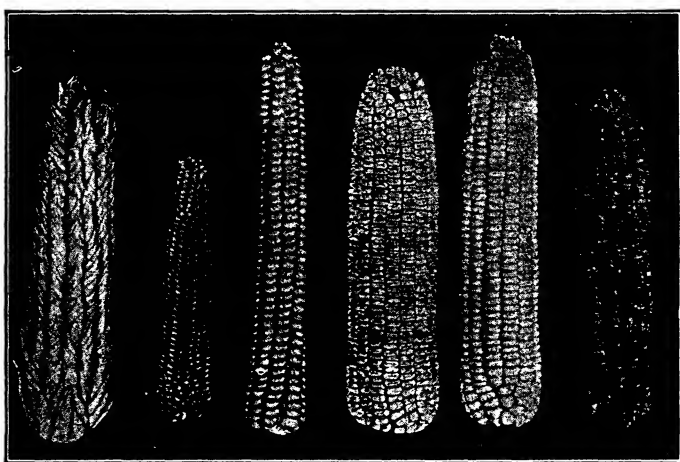


FIG. 48.—The six principal types of corn. From left to right, pod corn, pop corn, flint corn, dent corn, soft corn and sweet corn. (From Robbins' "*Botany of Crop Plants*" after Montgomery.)

consists of a sterile and a fertile flower. All that remains of the sterile flower are the lemma and palet. The fertile flower consists of a pistil composed of an ovary or "kernel" and a long, hairy style, the hairs serving as stigmas for pollen reception. The ovary is borne upon the end of a short rachilla which bears 2 empty glumes, and a lemma and palet for both fertile and sterile flowers. The empty glumes, lemmas and palets form the "chaff." The rachis and chaff constitute the cob of the corn ear. The cup in which the mature kernel or grain of the corn rests is formed of six envelopes, viz: two empty glumes, a lemma (flowering glume) and palet of the kernel, and a lemma and palet of the sterile flower. Both empty glumes are thick and horny, are lined below with spongy tissue, and tapered into thin, papery ends: the lemmas and palets are thin and membranous. Unicellular, pointed, non-glandular hairs and 3-celled, blunt-ended hairs occur in the depressions at the bases of the glumes.

**Varieties of Corn.**—A number of sub-species and varieties of maize are under cultivation in America. Of these the most important types are as follows:

1. *Zea Mays indentata*, yielding "Dent Corn," the grains of which are characterized by their tooth form and the presence of a dent or depression at the apex. Horny endosperm occurs at the sides of the kernel and starchy endosperm occurs beneath, extending to the top.

2. *Zea Mays indurata*, yielding "Flint Corn," characterized by its nearly round kernels having a smooth, rounded or convex summit, the starchy endosperm being surrounded by the horny endosperm.

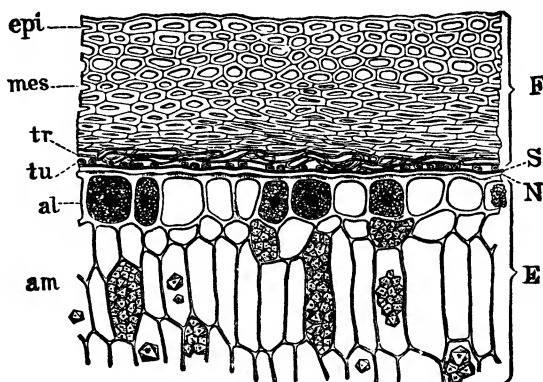


FIG. 49.—Maize. Kernel in cross section through dorsal side. *F*, pericarp: *epi*, epicarp, *mes*, hypoderm (mesocarp), *tr*, cross cells, *tu*, tube cells (endocarp). *S*, spermoderm. *N*, perisperm. *E*, endosperm: *al*, aleurone cells, *am*, starch cells.  $\times 160$ . (After Winton and Winton, "The Structure and Composition of Foods," J. Wiley & Sons, Inc.)

3. *Zea Mays saccharata*, yielding "Sweet Corn," the dried grains of which are horny and translucent throughout and greatly wrinkled, the wrinkling being due to evaporation of water in the cell sap vacuoles of the kernel. The ability of this sub-species to mature starch grains normally has been lost. The endosperm contains relatively few spheroidal starch grains up to  $10\mu$  in diameter and considerable gummy matter and some sugar.

4. *Zea Mays everta* which yields "Pop Corn," a type having small kernels used for popping. The grains have a translucent and horny endosperm, the cells of which are filled with polygonal starch grains possessing central, rarefied areas. By quickly heating the kernels at  $145^{\circ}$  to  $160^{\circ}\text{C}$ . the starch grains are caused to burst and the internal pressure causes the bursting of the endosperm cells and the splitting of the pericarp.

5. *Zea Mays amylacea* which yields "Soft Corn," a type shaped like flint corn and grown as a silage or fodder crop. The grains are soft owing to no horny endosperm being formed.

The "Dent" and "Flint" corns are used chiefly in the preparation of corn products.

**Histology of the Corn Kernel.**—A longitudinal section made through the center of the lesser diameter of the dent on flint corns shows the following regions:

1. **Pericarp**, made up of (a) *epicarp* of elongated, distinctly porous cells without hairs: (b) *mesocarp* of about 6 layers of cells similar to the epicarp

but with thicker walls: (c) *spongy parenchyma*, a layer of branching and anastomosing parenchyma cells and large air-spaces, best seen in surface sections, and (d) *tube cells*, appearing circular in outline and isolated.

2. **Spermoderm**, a thin layer of elongated cells becoming yellow with alkaline solutions, and closely adherent to the pericarp.

3. **Perisperm**, a layer with indistinct cell walls, the granular contents of which stain deep blue with chlor-zinc iodine T.S.

4. **Endosperm**, composed of (a) the *Aleurone layer* and (b) *Starch parenchyma*. The starch-parenchyma in the dent and flint corns shows an outer horny zone (*horny endosperm*) the cells of which are closely packed with polyg-

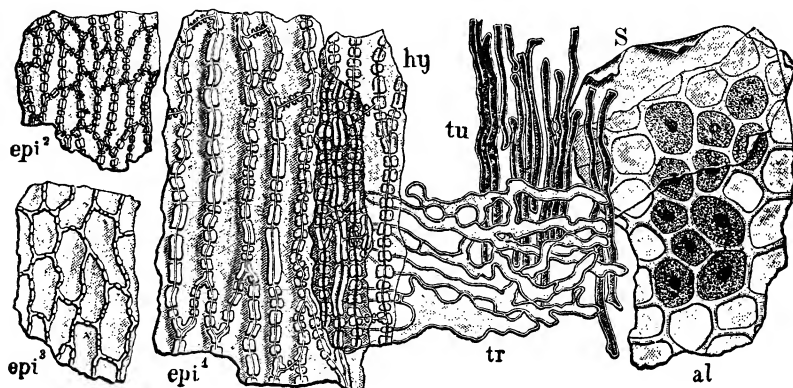


FIG. 50.—Maize. Bran coats in surface view. *epi*<sup>3</sup>, epicarp at base; *epi*<sup>2</sup>, epicarp at apex. Layers on dorsal side: *epi*<sup>4</sup>, epicarp; *hy*, hypoderm; *tr*, cross cells; *tu*, tube cells; *S*, spermoderm; *al*, aleurone cells.  $\times 160$ . (After Winton and Winton, "The Structure and Composition of Foods," J. Wiley & Sons, Inc.)

onal starch grains with but a few rounded forms, and an inner mealy zone (*starchy endosperm*) the cells of which are larger and contain mostly rounded starch grains.

5. **Embryo**, consisting of a shield-shaped portion of the cotyledon called the *scutellum*, and a *plumule* and *radicle* which are enveloped by the *cotyledonary sheath*. The embryo is known in commerce as the "*germ*" and contains oil and protein but no starch.

**Corn Products.**—A number of these have been used as foods and drugs and some of them as adulterants for foods, drugs and spices.

*Whole and cracked corn* are used as poultry and stock food. They contain vitamins A, B<sub>1</sub> and B<sub>2</sub>.

*Corn meal* is prepared by grinding the endosperm after the germ and most of the bran are removed. It contains lumps of horny and floury endosperm which possess parenchyma containing polygonal and spheroidal starch grains from 15 to 35 $\mu$  in diameter and with central, circular to 3- to 5-cleft hilum, fragments of the pericarp and spermoderm, the epicarp and mesocarp cells of which possess thick, porous walls, fragments of spongy parenchyma with star-shaped cells and large air-spaces and vermiform tube cells. Corn meal is

used to make corn bread and muffins, mush, as a dusting powder in the frying or grilling of sea food, etc., or it may be bolted to make corn flour.

*Hominy* and *grits* are products obtained by steaming the kernels, removing the hulls and germ by machinery and grinding the horny and starchy part of the kernel remaining to varying degrees of fineness. The coarser meal is *hominy*, the less coarse meal is called "*grits*." Hominy is usually made from white corn.

*Corn flour* consists of the ground and bolted endosperm, and has been used as a constituent of griddle cake flours and as an adulterant of wheat flour. It contains parenchyma cells of the endosperm and numerous starch grains.

*Corn starch* is official in the U.S.P. (see *Amylum*).

*Corn oil* is a fixed oil obtained from the germ (see *Oleum Maydis*).

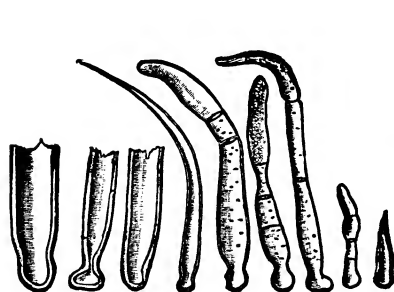


FIG. 51.

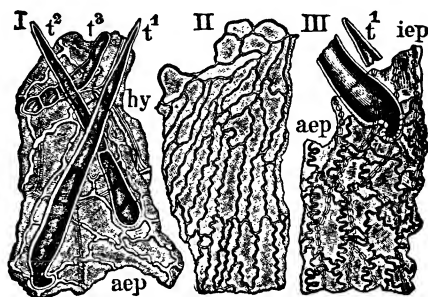


FIG. 52.

FIG. 51.—Maize. Hairs from different parts of cob.  $\times 160$ . (After Winton and Winton "Structure and Composition of Foods," J. Wiley & Sons, Inc.)

FIG. 52.—Maize. I, tissues from base and II, tissues from tip of flowering glumeis. III, tissues from near edge of membranous tip of thick empty glume. aep, outer epidermis with  $t^1$ ,  $t^2$ , and  $t^3$  one, two, and three-celled hairs respectively; hy, hypoderm; iep, inner epidermis.  $\times 160$ . (After Winton and Winton, "Structure and Composition of Foods," J. Wiley & Sons, Inc.)

*Corn bran* consists of the hulls (pericarp, spermoderm and perisperm) and has been employed to adulterate wheat and rye bran.

*Corn cobs* are employed as fuel, in the manufacture of pipes and as a source of several chemical products as furfural, adhesives, etc. In the ground condition they have been used to adulterate wheat and rye brans, and powdered drugs and spices. The diagnostic elements found in ground corn cob are fragments of the lemma and palet with thin wavy walls and thin-walled, unicellular and uniseriate, non-glandular trichomes, the porous and non-porous epidermal cells of the empty glumes, the numerous fragments of fibrovascular bundles showing spiral, annular, scalariform and pitted tracheæ and thin-walled sclerenchyma fibers and the numerous sclerenchyma cells from the woody region of the cob and empty glumes with walls of variable thickness.

*Corn flakes* consist of rolled, cooked or roasted horny endosperm or grits to which sugar and salt may be added.

#### ZEA N.F. (ZEA)

**Synonyms.**—*Corn-silk*, Stigmata Maydis; *Ger.* Maispistille; *Fr.* Filament de Mais.

**Botanical Origin.**—*Zea Mays* Linné.

**Part Used.**—Fresh styles and stigmas, collected when the corn is in milk. It should be used in the green condition for the manufacture of pharmaceutical preparations.

**Habitat.**—Tropical America; extensively cultivated.

**Plant.**—An annual herb (see *Maize*).

**Description.**—It occurs in masses consisting of more or less tangled slender filaments from 10 to 20 cm. in length of a light green, greenish-yellow, brown, reddish-orange, pink or purplish-red color. Each entire filament consists of a long style (up to 30 cm.) and a bifid stigma, the segments being slender and up to 3 mm. in length. The odor is slight. The taste is slightly sweet.

**Histology.**—The styles consist of an epidermis of rectangular cells surrounding a matrix of parenchyma through which course two parallel vascular bundles, possessing slender annular and spiral tracheæ. Many of the epidermal cells, particularly of the distal region, show outgrowths in the form of multicellular hairs from 200 to 800 $\mu$  long. The basal portion of each of these hairs comprises two to five united cells, the distal portion usually unicellular. Numerous spinose pollen grains are also evident either adhering to the style or upon the stigmatic surfaces. The purplish-red styles contain a purplish-red sap.

**Constituents.**—*Volatile alkaloid, maizenic acid*, sugar, two resins, fixed oil, etc.

**Identity Test.**—A yellow or yellowish-orange solution is produced by digesting 1 Gm. of the fresh drug in 10 cc. of diluted alcohol and filtering, separate portions of which, on the addition of acids, become distinctly red to yellowish-orange; on the addition of alkalies, yellow to olive; on the addition of ferric chloride T.S., olive-brown or olive changing to olive-brown, and on the addition of an aqueous solution of potassium alum, reddish or purplish.

**Uses.**—Diuretic.

**Average dose,** 4 Gm. (60 grains).

**Preparations.**—*Zea Fluidextract*, 4 cc. (1 fl. dr.); *Compound Serenoa and Sandalwood Elixir* (from fld. ext.), 4 cc. (1 fl. dr.).

#### STARCH U.S.P. (AMYLUM)

**Synonyms.**—*Corn Starch*; *Ger.* Maisstärke; *Fr.* Fécule de Maize.

**Botanical Origin.**—*Zea Mays* Linné.

**Part Used.**—Starch granules separated from the grain.

**Purity Rubric.**—Not more than 0.5 per cent. of ash, and not over 14 per cent. of moisture.

**Habitat and Plant.**—See *Maize*.

**Description.**—A fine white powder or in irregular, angular, white masses. The odor is not distinct. Starch is insoluble in cold water or alcohol. The taste is starchy at first but subsequently sweet. If 1 Gm. of starch is boiled with 15 cc. of distilled water and the mixture cooled, a translucent, whitish jelly is formed. Upon triturating about 0.5 Gm. of starch with 5 cc. of distilled water, the mixture is neutral to litmus. The presence of any iron in starch may be detected by adding 10 cc. of distilled water to 1 Gm. of starch, acidifying

with 0.5 cc. HCl and adding 3 drops of potassium ferrocyanide test solution, when the mixture will exhibit a blue color within 1 minute, if iron is present.

**Microscopical Characteristics.**—Corn starch grains are simple, polygonal or rounded, 3 to  $35\mu$  in diameter; hilum circular or a 2–5 rayed cleft; lamellæ indistinct; polarization cross distinct; no marked play of colors with selenite plate. Iodine T.S. colors starch grains a purplish-blue to deep blue.

**Preparation.**—The dent or flint corn fruits are soaked in running water kept at a temperature of about  $60^{\circ}\text{C}$ . for several days. They are then crushed

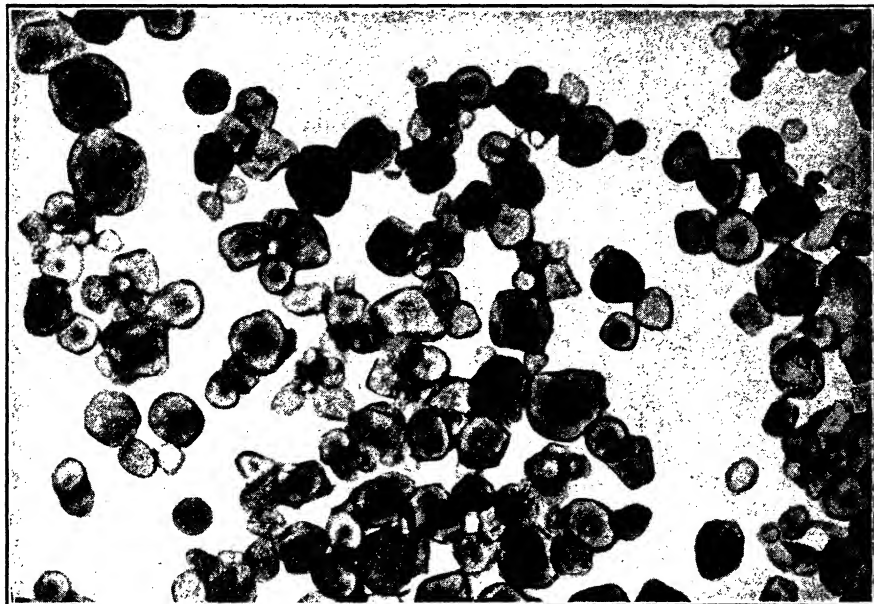


FIG. 53.—Corn starch. Photomicrograph,  $\times 250$ .

between burr-stones and the paste conveyed to sieves by means of water and strained. The strained mass is then ground and carried to bolting cloth sieves. The white fluid containing the starch is then run into vats where the starch settles out. A caustic soda solution is then employed to rid the starch of proteins and oil. The supernatant fluid is then decanted and the starch washed with water to remove alkali. Upon standing the starch separates out and is then dried.

**Uses.**—Starch is a nutrient and demulcent. It is employed pharmaceutically as a base for dusting powders and insufflations, as a dusting powder for uncoated pills to prevent them adhering to each other and, in the form of glycerite (*Glyceritum Amyli U.S.P.*), as an emollient and base for suppositories. It is also an antidote for iodine and bromine poisoning.

#### DEXTROSE U.S.P. (DEXTROSUM)

Dextrose or *D*-Glucose ( $\text{C}_6\text{H}_{12}\text{O}_6 \cdot \text{H}_2\text{O}$ ) is a sugar usually obtained by the hydrolysis of starch. It occurs as colorless crystals or as a white crystalline



powder or as white granules without odor and having a sweet taste. An aqueous solution (1 in 20) is neutral to litmus and dextrorotatory. A few drops of this solution added to 5 cc. of hot alkaline cupric tartrate T.S. gives a copious red precipitate of cuprous oxide.

**Uses.**—Nutrient in malnutrition, hypoglycaemia, and diuretic; in the preparation of dextrose solutions. Dextrose is used intravenously in 5 to 10 per cent. sterile solution in cardiac insufficiency, insulin hypoglycaemia, acidosis, toxæmias, uncontrollable vomiting, etc.; in 20 to 50 per cent. solutions in diabetic coma, anuria, edemas, acute toxæmias and for the reduction of intracranial pressure in brain tumor, fracture of the skull, encephalitis, etc. It is employed in the form of the official injection of dextrose and sodium chloride, injected into varicose veins, for their obliteration. In 33½ per cent. solution it is used in the management of shock following the administration of insulin in the treatment of schizophrenia.

**Preparations.**—Dextrose Injection, U.S.P., Dextrose and Sodium Chloride Injection, U.S.P.

**White Dextrin (Dextrinum Album)** is a mixture of soluble carbohydrates, amylopectin, achroodextrin, erythrodextrin and maltodextrin, together with some unconverted starch. It is obtained by the incomplete hydrolysis of starch by the action of an acid. It occurs as a white amorphous powder producing a harsh sensation when rubbed in the hand; odorless; taste sweet; partly soluble in cold water, completely soluble in 3 parts of water on boiling. Used in preparing dextrin paste and salicylic acid pencils and as an emulsifying agent.

**Liquid Glucose (Glucosum Liquidum) U.S.P.** or *Glucose* is a colorless or yellowish, thick, syrupy liquid with a sweet taste obtained by the incomplete hydrolysis of starch. It consists chiefly of dextrose ( $C_6H_{12}O_6$ ) with maltose, dextrans and water. Used in pharmacy as an excipient and diluent; in medicine as a nutrient, local dehydrating agent and diuretic.

#### CORN OIL U.S.P. (OLEUM MAYDIS)

**Synonyms.**—Maize Oil; *Ger.* Maisöl; *Fr.* Huile de Mais.

**Definition.**—The refined, fixed oil expressed from the embryo of *Zea Mays* Linné (Fam. *Gramineæ*).

**Description.**—A clear, light-yellow, oily liquid. It has a faint characteristic odor and taste.

Corn oil is slightly soluble in alcohol, but is miscible with ether, chloroform, benzene, and with petroleum benzin. Specific gravity: 0.914 to 0.921, at 25°C.

**Tests for Identity and Purity.**—Mix 5 cc. of Corn Oil in a test tube with 5 cc. of a mixture of equal volumes of amyl alcohol and a solution of sulfur in carbon disulfide (1:100). Warm the mixture until the carbon disulfide is expelled. Then immerse the test tube to one-third of its depth in a boiling, saturated aqueous solution of sodium chloride: no reddish color develops within fifteen minutes (cottonseed oil).

The free fatty acids in 10 Gm. of Corn Oil require for neutralization not more than 2 cc. of tenth-normal sodium hydroxide. Saponification value:

not less than 188 and not more than 193. Iodine value: not less than 112 and not more than 128. Unsaponifiable matter: not more than 2 per cent.

**Production.**—The source of Corn Oil is the germs (embryos) of the kernel which are separated from the hulls and starch grains in the preparation of other corn products. Because of the fat present the germ floats on the surface of the vat liquor while the hull and starch sink. The germs are thoroughly washed to remove starch, then dried and crushed under pressure to separate the oil from the germ meal. The crude oil is then refined by neutralization, bleaching, and

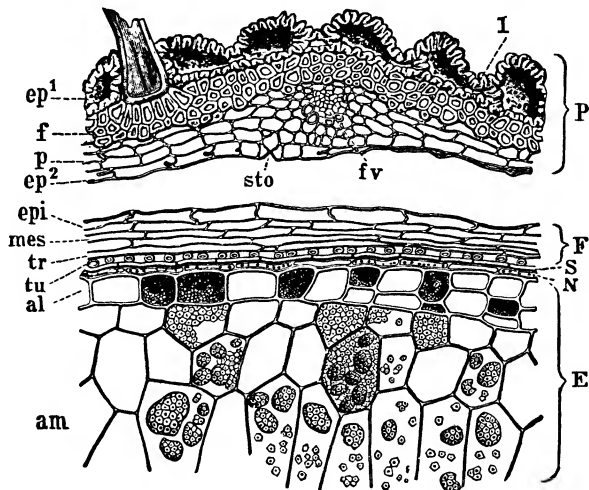


FIG. 54.—Rice (*Oryza sativa*). Palet and grain in cross section. *P*, palet: *ep*<sup>1</sup>, outer epidermis with basal portion of hair; *f*, hypodermal fibers; *p*, spongy parenchyma with bundle (*fv*); *ep*<sup>2</sup>, inner epidermis with stoma (*sto*). *F*, Pericarp: *e**pi*, epicarp; *mes*, mesocarp; *tr*, cross cells; *tu*, tube cells. *S*, spermoderm. *N*, perisperm. *E*, endosperm: *al*, aleurone grains; *am*, starch-bearing parenchyma  $\times 160$ . (From Winton and Winton, "The Structure and Composition of Foods," J. Wiley and Sons, Inc.)

refrigerating to separate the fractions having high melting point (olein from stearins and palmitins). It is then deodorized.

**Uses.**—Corn Oil has similar uses to those of other bland vegetable oils in the culinary arts. It may be employed in the manufacture of oleomargarine, vegetable lard, mayonnaise, and as a salad oil. In pharmacy, it is used as a diluent for viosterol in the preparation of viosterol in oil, as a solvent for injections of menadione, estrogenic substances, etc.

#### RICE POLISHINGS U.S.P. (PERPOLITIONES ORYZÆ)

**Synonyms.**—*Rice Bran*, *Tikitiki*.

**Botanical Origin.**—*Oryza sativa* Linné.

**Part Used.**—The fine, flaky pericarp and spermoderm fragments, the embryo, aleurone layer, and outer adhering cells of the starchy endosperm of the grain.

**Purity Rubric.**—Not more than 40 per cent. of rice starch and not more than 10 per cent. of rice hull or other foreign matter.

**Habitat.**—Asia.

**Plant.**—*Oryza sativa* L., the common cultivated rice, is an annual native to warm parts of Asia and cultivated as a major food crop in the Orient since 2800 B.C. The species consists of upland and lowland varieties which grow best in swampy or moist soil. In the United States the lowland variety is almost exclusively grown as a cereal. The plant has a fibrous root system

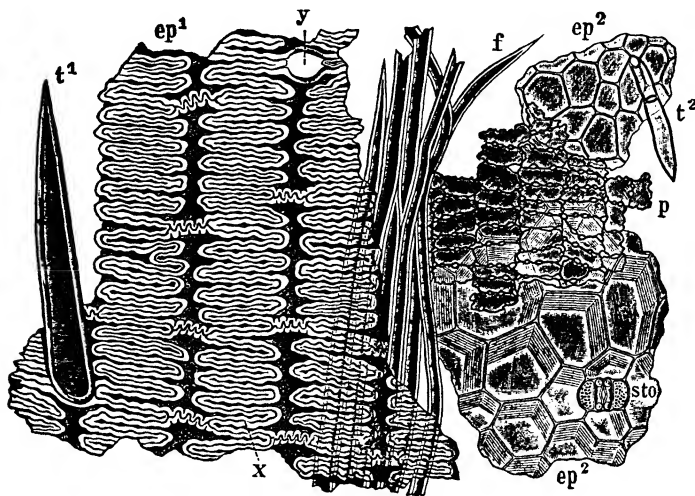


FIG. 55.—Rice. Palet in surface view. *ep¹*, outer epidermis with sinuous walls (*x*); *f*, hypodermal fibers; *p*, spongy parenchyma; *ep²*, inner epidermis with stoma (*sto*) and hair (*t²*). (After Winton and Winton, "The Structure and Composition of Foods," J. Wiley & Sons, Inc.)

which gives rise to 4 or 5 hollow stems (culms) attaining a height of from 2 to 6 feet and having alternate leaves with blades 8 to 12 inches in length and open,

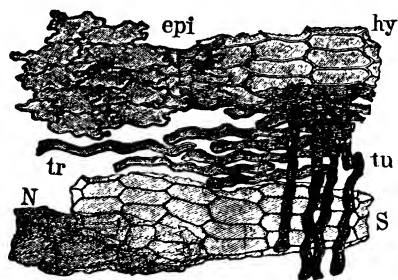


FIG. 56.—Rice Bran. Elements in surface view. *epi*, epicarp; *hy*, hypodermis; *tr*, cross cells; *tu*, tube cells; *S*, spermoderm; *N*, perisperm.  $\times 100$ . (From Winton and Winton, "The Structure and Composition of Foods," J. Wiley and Sons, Inc.)

decurrent leaf sheaths. The inflorescence is a panicle of laterally compressed, one-flowered spikelets. Each spikelet possesses a slender axis or rachilla bearing 2 small scale-like glumes, a minute rudimentary glume, a parchment-like, 5-nerved lemma and a 3-nerved palet, 2 small oval lodicules, 6 stamens and a pistil with a smooth ovary and usually 2 styles, sometimes a rudimentary third style. The fruit is a caryopsis surrounded by lemma and palet.

**Production and Commerce.**—While rice has been a minor food crop in the United States, its popularity is steadily increasing. It is cultivated chiefly in

Louisiana and Texas and to a lesser extent in Arkansas, California and the Carolinas. Most of the rice and rice polishings used in this country have

been imported from British India, China, Netherlands, Hong Kong, Thailand, Belgium, Denmark and the Philippines.

Since most of the vitamin content of rice is localized in the embryo and aleurone layers of the grain, the quality of rice polishings is proportional to the number of the fragments present from the embryo and aleurone layer.

**Description.**—A fine, flaky, yellowish-white to pale orange powder with a non-rancid odor and sweetish taste. It should be preserved against the attack of insects.

**Histology.**—Numerous scale-like fragments of the pericarp consisting of the epicarp with transversely-elongated cells having deeply sinuous end walls, the mesocarp of transversely-elongated cells, the cross cell layer of vermiform cells, all pressed together and traversed by elongated tube cells; fragments of the spermoderm and perisperm of delicate transversely-elongated cells arranged in parallel rows, the former staining yellow, the latter blue with chlor-zinc iodine T.S.; fragments of the aleurone layer of rectangular to polygonal-shaped cells containing protein granules and oil globules; fragments of the embryo with small, thin-walled, rectangular and polygonal cells containing protein granules and oil globules; fragments of starchy endosperm of polygonal to radially-elongated parenchyma cells containing starch grains; numerous starch grains, simple and in oval or spheroidal aggregates, the individual grains up to 10 microns in diameter; occasional irregular fragments of the hull of pale orange color which, when heated in a 1 per cent. solution of sodium hydroxide and mounted, exhibit rows of large, sinuous, thick-walled, siliceous outer epidermal cells of the pale with or without tooth-like projections, sometimes interspersed with short unicellular hairs or their bases.

**Constituents.**—*Vitamin B<sub>1</sub>*, and other members of *B* complex, protein, fixed oil, starch, etc.

**Adulterants.**—Rice hulls, broken rice grains, insects, and excess starch. If rice polishings are passed through a No. 30 sieve, not more than 10 per cent. should remain on the sieve.

**Uses.**—In the preparation of extract of rice polishings and as a source of vitamin *B<sub>1</sub>*.

**Preparation.**—Rice Polishings Extract (*Extractum Perpolitionum Oryzæ*) U.S.P. *Extracto de Salvado*, 8 cc. (2 fl. dr.). It contains in each cc., not less than 20 U.S.P. units of Vitamin *B<sub>1</sub>*.

## CEREAL AND CEREAL PRODUCTS

The term "cereal" [From *Ceres*, the goddess of corn (harvest)] in its strictest application, pertains to any graminaceous plant bearing an edible grain, or to the seed or grain of such plants. In its wider application as commonly employed, the term includes products from certain other plants than those of the *Gramineæ*. Thus "*Buckwheat*," the fruit of *Fagopyrum esculentum* Moench (Fam. *Polygonaceæ*), is classed with the cereals as it is one of the bread grains, though the family is one of the dicotyledons and not one of the grasses.

The chief or more commonly used cereal products of the *Gramineæ* are Wheat, Rye, Barley, Oats, Rice, Corn, usually in the form of flour or meal or prepared by special processes as breakfast foods.

The cereal grains are the most important generally used vegetable foods. Wheat, in its constituents, corresponds more closely with the requirements of the human organism than any other grain. Gluten, a water-insoluble protein, is present in higher percentage in wheat and the value of wheat flour depends on the amount of gluten present. Crude gluten is a complex mixture of the gluten proteins, cellulose, lecithin, starch, and mineral matter. The purified gluten contains two proteins, gliadin and glutenin.

Barley ranks about as wheat. It contains rather more protein but less gluten but it is rich in phosphates and iron. Barley is largely used in the manufacture of fermented beverages.

Rye has about the same proportion of starch, fat and protein as wheat but only contains traces of gluten. It contains vitamins A, B<sub>1</sub>, E and B<sub>2</sub>.

Oats are rich in fat but contain less starch than the other grains and require prolonged cooking to render them digestible.

Rice contains more starch than other grains but contains practically no fat and only a very small amount of protein. In order to make rice a suitable diet a fatty oil and some albuminoid must be added. Unpolished brown rice contains vitamins A and B<sub>1</sub>; while polished rice is entirely devoid of vitamins.

Corn is more nutritious than rice but less digestible. Corn contains much starch and some fat but it is deficient in gluten protein material.

The excessive consumption of starchy food delays tissue-metamorphosis, causes an overproduction of adipose tissue, and often acidity and flatulence.

While few pharmacies carry the ordinary breakfast foods, most of them do carry in stock various kinds of prepared infant foods and diabetic food products. The pharmacognosist is more concerned with the by-products of the various grains that have frequently been employed in the fraudulent adulteration of many kinds of powdered or ground drugs. It is necessary for him to be familiar with the microscopic characteristics of the grain histological elements in order that he may detect their presence when used as adulterants.

The tissues of the various cereal grains are quite distinctive and usually serve to determine the particular grain from which a given tissue element is derived.

**Grain.**—The term *grain* includes such fruits of the cereals (*Gramineæ*) and buckwheats (*Polygonaceæ*) as are valuable as food for man and stock animals.

The impurities of grain, as reported by Winton, include weed seeds, various insects or their remains, dirt, straw, ergot, spores of smuts, rusts, algæ, yeasts, bacteria, and other foreign substances. The grain may be damaged by the growth of molds, and other fungi, or by the sprouting of the grain itself.

The nature and purity of grain products may readily be determined by microscopic examination. However, a thorough understanding of the microscopic structures of the whole grain is essential for the diagnosis of the products.

**Meal, Flour, and Bran.**—Milling is the mechanical process of grinding grains and having for its primary purpose the separation of the endosperm from the

germ tissues and bran coats and secondarily to produce a finely comminuted product.

*Meal* is coarsely ground grain.

*Flour* is the finely ground and bolted meal. By bolting is meant the sifting of the ground product through silk or bolting cloth to remove the bran and shorts.

*Bran* is the coarse outer hulls left after bolting the meal.

*Middlings* or *Shorts* is a mixture of pericarp and seed coat, endosperm portions adhering to the seed coat, and germ tissue.

*Chaff* is a collective term for glumes, palet, lodicules, rachis, rachilla, and bristles from the mature spikelet.

*Graham flour* is a whole kernel product. It receives its name from its popularizing by Dr. Graham, and is commonly applied to the wheat product as also is the term "flour" unless otherwise specified.

**Cereal Breakfast Foods.**—The popular and important cereal breakfast foods are derived from wheat, oats, corn and rice chiefly and prepared by a variety of processes. Many of the products are subjected to a preliminary cooking and drying in order that their preparation for use will require a minimum of time as well as aiding in the keeping qualities of the product.

In some cases the whole kernel is subjected to a steaming process after which it is crushed between rollers and finally dried. Oats and wheat are the more commonly used *rolled* kernel products.

The crushed, steamed product may be shredded and baked as in the "shredded wheat," or the cooked product may be marketed in the form of granules or flakes. In another form, called "puffed," the kernels are first steamed, then heated under pressure with the pressure being suddenly released thus causing a greatly distended kernel.

Malted cereals are usually prepared by adding malted barley to the moist, ground grain and, by maintaining a definite temperature for the mixture, a portion of the starch is converted to maltose and dextrin, after which the product is crushed, rolled and dried by means of hot plates or rollers.

In most corn products, the germ tissue is removed in order to prevent the product becoming rancid, since the germ tissues contain oil and fat. The germ tissue is rarely removed in wheat or oat preparations as they contain a sufficiently low fat content.

**Prepared Food for Invalids and Infants.**—These products are frequently prescribed as the exclusive diet for infants or invalids and the character of the product may be the only food suitable for the particular individual.

The chief ingredient of many of these products is either wheat or mixed cereals high in starch content.

*Gluten flour* and allied products are chiefly intended for the use of diabetics in such cases where carbohydrate foods are limited or entirely excluded. Many of the products called "health foods for diabetics" have been found to contain higher percentages of carbohydrates than could be considered as not injurious to diabetics. Starch, sugar and dextrin, the main carbohydrates, should not be present to an appreciable extent in such products.

**Cattle Foods.**—Bran, Shorts or Middlings, and Mill Run products are largely used as cattle feed. Mill Run Mixed Feed is a mixture of bran and shorts and often contains the Screenings. Screenings consist of the damaged, or broken kernels and frequently weed seeds which may be mechanically separated before milling a flour or meal.

The bran content is chiefly valuable as a roughage rather than as a nutrient.

**Inflorescence of Gramineæ.**—The inflorescence of the cereal plants (*Gramineæ*) may either be in heads or spikes (compactly arranged) or loosely in racemes or panicles, but in either case it consists of spikelets borne on a rachis, each spikelet with one or several flowers.

The spikelet is subtended by two *empty glumes*. The flowers of the spikelet are borne on a short axis, the *rachilla*, and each flower in the axil of a *lemma* (outer palet) which usually overlaps the edges of an *inner palet*. Both outer and inner palet envelop the mature fruit.

Two small papery scales, called *lodicules*, occur at the base of the flower within the enveloping palets.

Normally there are present three stamens, which disappear after pollination, and one pistil. The ovary of the pistil contains one ovule which ripens into the single seed.

*Chaffy grains* are those in which the “chaffy structures” tightly invest the fruit and are removed along with the fruit from the straw on threshing.

*Naked cereal grains* are those from which the chaff is readily separated during the winnowing process.

*Most varieties of oats, barley and rice* are *chaffy* cereals, usually enveloped only by the flowering glume and palet.

*Common wheat, corn and rye* are *naked* cereals.

*Spelt* is one of the so-called *chaffy wheats*, a group in which the fruit is not separated from the floral envelopes on threshing and which is not only enveloped by the lemma and palet but also by the empty glume.

The *empty glumes*, of which normally there are two, usually remain with the straw on threshing, though in some cases as in the *spelts*, they are attached to the grain and envelop it.

The *lemma* (*flowering glume*) may be present, as in *chaffy* cereals, or absent, as in *naked* cereals, after threshing and winnowing.

The *palet* (inner envelope of the flower) as with the lemma may be present (*chaffy* cereals) or absent (*naked* cereals). Both the palet and flowering glume have characteristic diagnostic tissue elements. Both structures vary in the different grains. They may be thick and horny or, in some cases, membranous; smooth or rough; an awn may be present or they may be awnless; they may have more or less pronounced nerves, keels, or wings and these may have stiff hairs numerous or few to none.

The fruit is usually characterized by the presence of a groove, varying from a wrinkled or sunken area to a decided cleft, and by the presence of hairs which are most abundant at the apex where they form a tuft.

**Diagnostic Histological Elements.**—The chief diagnostic histological elements of the cereals are the starches, the hairs, the cross cells both in character and arrangement, and the epicarp cells.

*Starches.*—In all cereal starches the hilum is central but is not always distinct.

Rye, wheat and barley have two kinds of starches: one large circular to lenticular grains with mostly indistinct lamellæ and hili, and the other kind as small rounded or angular grains.

The starch grains of *rye* are the larger of the three, often exceeding  $50\mu$  in diameter, some up to  $64\mu$ . They frequently show distinct lamellæ and a star-shaped cleft. The larger grains present in *wheat* are usually less than  $45\mu$ , rarely exceeding this or rarely up to  $50\mu$ . The larger grains of barley are rarely up to  $35\mu$ , and most of the grains are less than  $30\mu$  in diameter.

*Oat starch* grains are comparatively small, rarely exceeding  $10\mu$  and commonly occur in aggregates of few to many individual grains. With polarized light they show brilliant crosses. The aggregates usually are oval-shaped or spindle-shaped.

*Rice starch* grains are also usually in aggregates and these are much larger masses than those of oats. The individual grains are similar to those of oats, occurring as polygonal forms with indistinct hili and up to 10 microns in diameter.

*Corn starch* grains are polygonal in form, have a very distinct hilum often with radiating clefts, and may exceed  $30\mu$  in diameter. They are the largest of the commercial polygonal starches (corn, oats, rice and buckwheat).

*Hairs.*—In *wheat*, the hairs usually have thick walls and a narrow lumen. The cavity is commonly less in breadth than the thickness of the walls. They are broad or globular at the base and taper to a rather sharp apex, and vary in length up to  $1000\mu$ .

In *rye*, the hairs usually are the reverse of those in wheat in that the width of the cavity is greater than the thickness of the walls of the hair and usually extends clearly into the apex of the hair.

In *barley*, the hairs are much shorter than those of wheat or rye, as a rule, but some of the *lodicule hairs* may range up to  $1300\mu$ . The hairs are characterized by their cavities, which often are several times the thickness of the walls in their breadth, their rather blunt apex, and their great variety, some showing branching.

The barley pericarp hairs somewhat resemble those of wheat but are shorter, mostly up to  $150\mu$ , rarely exceeding  $300\mu$  in length; others resemble rye hairs and a few of these may be up to  $650\mu$  in length.

In *oat*, a chaffy grain, are found the coarse hairs of the palet and long slender hairs of the epicarp. The hairs of the palet are short, stout and rigid; the hairs of the pericarp are long, some up to  $2000\mu$  in length, often broadest in the middle and tapering to both base and apex. They vary in length and in breadth of lumen, the long hairs with lumen narrower than the thickness of the walls and the short hairs with lumen broader than the thickness of the walls.



Lemma and palea in whole product	Wheat Triticum aestivum	Rye Secale cereale	Barley Hordeum vulgare H. distichon	Oats Avena sativa	Corn Zea mays	Rice Oryza sativa
	Absent	Absent	Present	Present	Absent	Absent
Hairs	Up to 1 mm. long with walls thicker than the lumen.	Up to 800 $\mu$ in length. Lumen of most of the hairs thicker than the walls.	Conical to elongated hairs; lumen may be thicker than walls or vice versa. Thick walled hairs up to 300 $\mu$ . Thin-walled hairs up to 650 $\mu$ . Lodicule hairs up to 1300 $\mu$ .	On keel of palea, hairs are dagger-shaped, some hooked, broad base. On epicarp, long hairs with walls thicker than lumen and up to 2 mm. also short hairs with lumen broader than walls.	Walls thinner than lumen. Unicellular or multicellular.	Dagger-shaped on lemma and palea of entire grain; up to 500 $\mu$ in length and 40 $\mu$ broad at base. Hairs absent on brown rice and polished rice.
Cross cells	Cross cells with porous, radial walls. Cells rectangular in swollen. Intercellular spaces rare.	Side walls thinner and less distinctly porous than wheat. End walls swollen or rounded. Pronounced intercellular spaces.	Two rows with non-porous walls. Intercellular-air spaces between side walls and angles.	Cross cells are very thin-walled.	Spongy parenchyma takes the place of cross cells.	Transversely elongated, tubular, wavy, vermiform cells.
Aleurone layer	Layer 1-cell thick. Cells rectangular in T.S. Rounded-polygonal in surface view.	Cells are similar to those of wheat. Many cells have bluish contents.	2-4 rows of cells thick. In T.S., cells are square or radially extended but in surface section rounded-polygonal.	One cell thick. Thinner walled cells than in wheat, rye or barley.	Aleurone in a single layer.	Cells rounded—polygonal with extremely thin walls.
Starch	Simple. Circular grains appearing lenticular on edge view. Large grains usually up to 45 $\mu$ , rarely to 50 $\mu$ . Hilar: central, appearing as a dot but usually indistinct. Lamellae: generally indistinct; when present concentric. Polarisation: cross indistinct except on edge of grain; no play of colors with selenite plate.	Simple. Grains similar in shape to wheat starch but many are larger. Large grains up to 64 $\mu$ in diameter. Hilar: indistinct in some grains, but a star-shaped central cleft in others. Lamellae: usually indistinct, when present concentric. Polarisation: cross distinct.	Simple. Grains have a similar shape to those of wheat but frequently tending to bulge on one side and so appear subreniform. Appear elliptical to lemon-shaped on edge view. Large grains usually 18 to 25 $\mu$ and occasionally up to 30 $\mu$ in length. Hilar: centric or circular or cleft, usually indistinct. Lamellae: concentric and usually indistinct. Polarisation: cross indistinct.	Compound or Simple. Grains polygonal, in ellipsoidal or rounded aggregates (up to 60 $\mu$ ) of from 2 to many grains. Spin-dle-shaped forms may be present. Single grains up to 10 $\mu$ in diameter. Hilar: indistinct. Lamellae: indistinct. Polarisation: cross distinct but no marked play of colors with selenite plate.	Simple. Polygonal to rounded. 10-35 $\mu$ in diameter. Hilar: circular or a two- to five-rayed cleft. Lamellae: indistinct. Polarisation: cross distinct but no marked play of colors with selenite plate.	Simple or 2- to many compound. Polygonal. 2-10 $\mu$ in diameter. Hilar: usually indistinct but occasionally a central cleft. Lamellae: indistinct. Polarisation: cross distinct but no play of colors with selenite plate.

The short hairs taper from base to apex whereas most of the long hairs taper from the middle to both base and apex.

**Cross Cells.**—In *wheat* the cross cells are distinctly beaded and rather thick-walled, the cells arranged side by side in rows and elongated transversely to those above and below. The end walls are never swollen and there are no intercellular spaces. The end walls are thinner than side walls but distinctly porous and beaded.

In *rye* the cross cells are nearly similar to those of wheat, but their end walls are rounded, swollen and thicker than the side walls, and intercellular spaces are pronounced.

In *barley* the cross cells occur in *two layers* and the walls of the cells are not porous or indistinctly porous. Intercellular spaces may occur especially in the outer layer of cross cells.

**Epicarp Cells.**—The epicarp cells of *wheat* are rather thick-walled and distinctly beaded (porous) both in side walls and the thinner end walls.

The epicarp cells of *rye* have thinner walls, the side walls less distinctly porous, than those of wheat and the walls are less distinctly beaded. Both take a yellow color with KOH solution.

The epicarp cells of *barley* are elongated, thinner-walled than in wheat, beaded, except at apex.

Those of *rice* are elongated with deeply sinuous and lobed end walls and wavy vertical walls.

#### OIL OF CITRONELLA

**Definition.**—A volatile oil obtained by distillation from *Cymbopogon Nardus* Rendle (*Andropogon nardus* L.) and *Cymbopogon Winterianus* Jowitt.

**Habitat.**—Asia.

**Production and Commerce.**—*Cymbopogon Nardus* or Citronella Grass, the chief source of the oil, is cultivated extensively in Ceylon where it is known as the Lenabatu. *Cymbopogon Winterianus* or Maha Pangiri Grass is cultivated in Malacca and Java. It yields an oil of citronella higher in geraniol content than the former species and is the more highly esteemed. The commercial supplies of citronella oil come from Ceylon, British Malaya, India, Guatemala, Honduras, Mexico, China, and Java.

**Description.**—A yellowish-green volatile oil with a sp. gr. of 0.898 to 0.920 at 15°C., a characteristic odor, a pungent taste, and miscible in all proportions with alcohol.

**Constituents.**—Chiefly *geraniol* and *citronellal*, the former being found in Java oils in amounts of from 72 to 94.9 per cent.

**Uses.**—Citronella oil is used as a mosquito repellent either in pure form or in a 25 per cent ointment. It is also employed as a perfume in some soaps.

**Adulterants.**—Kerosene, turpentine, alcohol, rosin, and other essential oils.

**Other Economic Products.**—**Lemon Grass Oil**, also known as *Oleum Graminis Citrati* and *Indian Verbena Oil*, is the volatile oil distilled from the overground parts of *Cymbopogon citratus* Stapf or from *Cymbopogon flexuosus*

**Stapf.** It is a dark yellow oil possessing an odor resembling somewhat that of lemon and verbenal. It contains from 53 to 85 per cent of citral, also linalool, geraniol and methyl-heptenone. It is used in perfuming soap. *Cymbopogon citratus* is cultivated in tropical countries, especially in Ceylon, India and the West Indies and is naturalized in Florida. *C. flexuosus* is cultivated along the Malabar coast of India and yields East Indian Lemon Grass Oil.

**Oil of Palmarosa** or Indian Geranium Oil is a volatile oil distilled with steam from the overground parts of *Cymbopogon Martini* Stapf var. *motia*, a grass native to India. It is a colorless or light yellow oil possessing an odor resembling geranium and rose. It contains from 65 to 95 per cent of geraniol and smaller amounts of an ester of capronic acid, dipentene, farnesol, etc. It is used in perfumery and as a substitute for oil of rose and oil of geranium.

**Oil of Vetiver** is a volatile oil distilled with steam from the roots of *Vetiveria zizanioides* Stapf (*Andropogon muricatus* Retz), a perennial grass probably native to Java and cultivated mainly in Java and Reunion Island. The main producing regions are in the vicinity of Garoet and Wonosobo, Java. It is a yellowish to brown fluid containing an ester of vetivenol, a sesquiterpene and a tricyclic sesquiterpene alcohol. It is used in perfumery, soaps and cosmetics.

#### PALMÆ (PALM FAMILY)

Tropical or sub-tropical shrubs, rarely trees, having unbranched trunks which are terminated by a crown of leaves, in the axils of which the flowers are produced. The leaves are well developed with pinnate (feather palms) or palmate blades (fan palms) and a fibrous sheathed, clasping petiole. The flowers are small, of one or two sexes, and crowded on a spike or spadix, which is subtended by a large bract or spathe which may become woody, as in the Coconut Palm. The perianth consists of 6 parts in 2 whorls (3 sepals and 3 petals) or it may be inconspicuous or absent. The stamens are 6 in number, rarely 3, inserted below the ovary. The ovary is superior, of 3 cells, with central placenta. The fruit is either a nut (*Areca*) with leathery epicarp, fibrous or cellular mesocarp and thin membranous endocarp, or a drupe (Coconut) with leathery epicarp, broadly fibrous mesocarp and stony endocarp, or a berry, as in the Date Palm, *Phoenix dactylifera*, with membranous epicarp, succulent mesocarp and soft succulent endocarp. The seeds are albuminous with reserve food frequently in the form of hard cellulose, as in the date and ivory-nut-palm.

#### SERENOA N.F. (SERENOA)

**Synonyms.**—*Saw Palmetto Berries*, *Sabal*, *Dwarf Palmetto*, *Fan Palm*.

**Botanical Origin.**—*Serenoa repens* (Bartram) Small.

**Part Used.**—The partially dried, ripe fruit.

**Purity Rubric.**—It contains not more than 1 per cent. of foreign organic matter and yields not more than 2 per cent. of acid-insoluble ash. It contains not more than 15 per cent. of moisture nor more than 10 per cent. of immature fruits which are not well filled, and whose surfaces are not creased or wrinkled.

**Plant.**—A fan palm, the main axis of which consists of a creeping rhizome, the anterior end of which arises a short distance from the soil and bears a dense cluster of leaves. Each leaf consists of an orbiculate blade with cleft segments and a long, stout, spiny-edged petiole. The inflorescence is a panicle. The fruit is a superior 1-seeded drupe.

**Habitat.**—In sandy soil from South Carolina to Florida, west to Arkansas and Texas.

**Production and Commerce.**—The palm thrives particularly well near the sea from South Carolina to Jupiter Inlet, Florida, where it forms in many

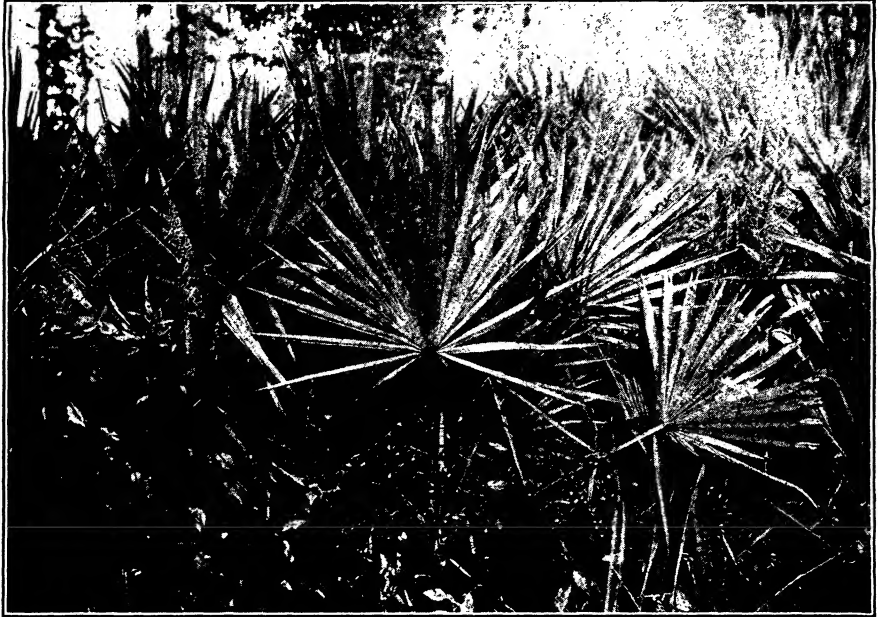


FIG. 57.—*Serenoa repens* or Saw Palmetto. (Photograph by Stuhr.)

places a dense growth stretching many miles inland. Collection of the fruit begins in September and lasts until late in January. The fruiting stalk with ripe fruits is cut with pruning shears and shaken over a hamper, the berries falling into the hamper. The filled hampers (baskets) are carried to a shed where the berries are placed in drying trays which are set on inclined racks exposed to the sun and sun-dried for 6 or 8 weeks, care being exercised to prevent them from becoming too moist by covering them during rains. After the fruits are thoroughly dried, they are garbled, those which are not well filled and whose surfaces are not creased or wrinkled are discarded. The fruits are then placed in wooden or tin containers, no preservative being added.

Saw Palmetto berries are shipped either in the fresh ripe state, in the semi-moist state or in the dried condition. The commercial supplies are obtained chiefly from the Cape Canaveral section of Florida.

**Description.**—A superior drupe of ellipsoidal or ovoid or somewhat globular outline, 1.5 to 3.5 cm. in length and 1 to 2 cm. in diameter; externally very dusky

red to brownish-black, smooth and somewhat oily, with a few large, more or less angular depressions due to the contraction of the sarcocarp, the summit marked by the scar of the style, and the base either with a short stalk or stem-scar; epicarp and outer portion of sarcocarp together forming a thin leathery shell enclosing the inner part of the sarcocarp and the hard, thin endocarp which is reddish-brown and fibrous. The endocarp possesses a smooth inner surface and envelops a hard ellipsoidal or ovoid, somewhat flattened, reddish-brown to pale brown seed. The seed shows a raphal scar extending its entire length and a micropyle near one end. The odor is aromatic; the taste sweetish, aromatic, slightly acrid.

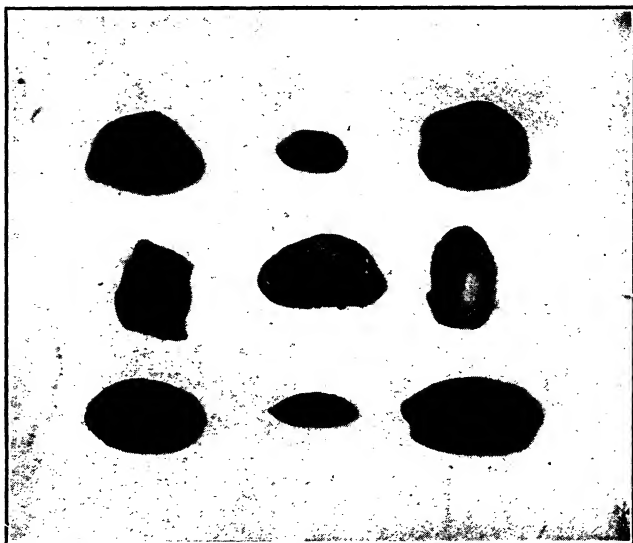


FIG. 58.—*Serenoa*,  $\times \frac{3}{20}$ . (Photograph by Stoneback.)

**Powdered Drug.**—Weak brown to moderate brown. Odor aromatic; taste sweetish, aromatic and slightly acrid. Fragments of inner epicarp and mesocarp (sarcocarp), the cells containing a reddish-brown to yellowish-orange amorphous substance; numerous yellowish-white fragments of endosperm, the walls thickened, occasionally irregularly, and usually with large pores; stone cells oval, polygonal or elongated, up to  $180\mu$  in length, with walls nearly colorless, up to  $35\mu$  in thickness with simple and branched pore canals and polarizing light with a distinct cross; numerous yellowish oil globules; few spiral tracheæ and occasional fragments of sclerenchyma fibers with thickened walls and narrow lumina.

**Constituents.**—*Volatile oil* (occurring in the sarcocarp), fatty acids, resin, lipase, glucose, etc.

**Uses.**—Mild diuretic and sedative in cystitis, enlargement of prostate, senile impotence, etc.

**Average Dose.**—1 Gm. (15 grains).

**Preparations.**—Serenoa Fluidextract, 1 cc. (15 minims); Compound Serenoa and Sandalwood Elixir, 4 cc. (1 fl. dr.).

ARECA N.F. (ARECA)

**Synonyms.**—Betelnut, Semen Arecæ, Areca; *Ger.* Arekanuss; *Fr.* Noix d'arec.

**Botanical Origin.**—*Areca Catechu* Linné.

**Part Used.**—The dried ripe seed.

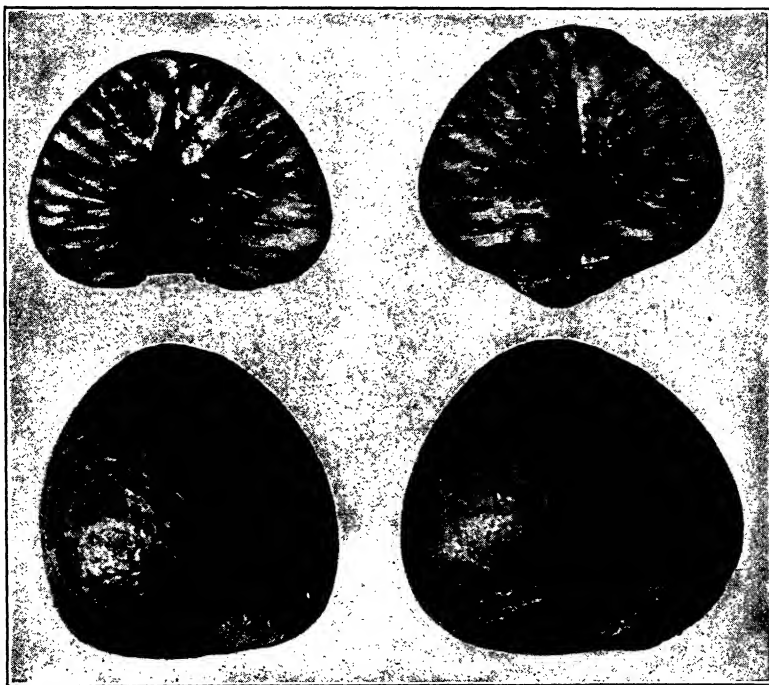


FIG. 59.—Areca,  $\times 2$ . Above, seed halved lengthwise showing marbled interior due to dark perisperm pervading light colored endosperm. Below, external view of seeds.

**Standard of Assay.**—Areca yields not less than 0.35 per cent. of ether-soluble alkaloids calculated as arecoline.

**Limit of Impurities.**—Not more than 2 per cent of adhering pericarp, not more than 1 per cent of foreign organic matter; not more than 2.5 per cent of total ash.

**Plant.**—A tall, spineless, feather palm with slender, unbranched stem terminating in a large crown. The leaves are pinnate with numerous leaflets up to 2 feet in length. The fruit is an ovoid, orange colored nut containing a single seed with large, ruminant endosperm and small embryo.

**Habitat.**—Asia and Malayan Islands. Naturalized in the American tropics.

**Production and Commerce.**—The Areca Nut palm is extensively cultivated in India, the Malay Archipelago and the East Indies for its seeds, called "Betel nuts," which are sliced and mixed with the leaves of *Piper belle* and lime and

chewed extensively by the natives as a masticatory. The fruits are gathered by the natives who detach them with bamboo poles and separate the seeds. The seeds are then usually boiled in water containing a small amount of lime

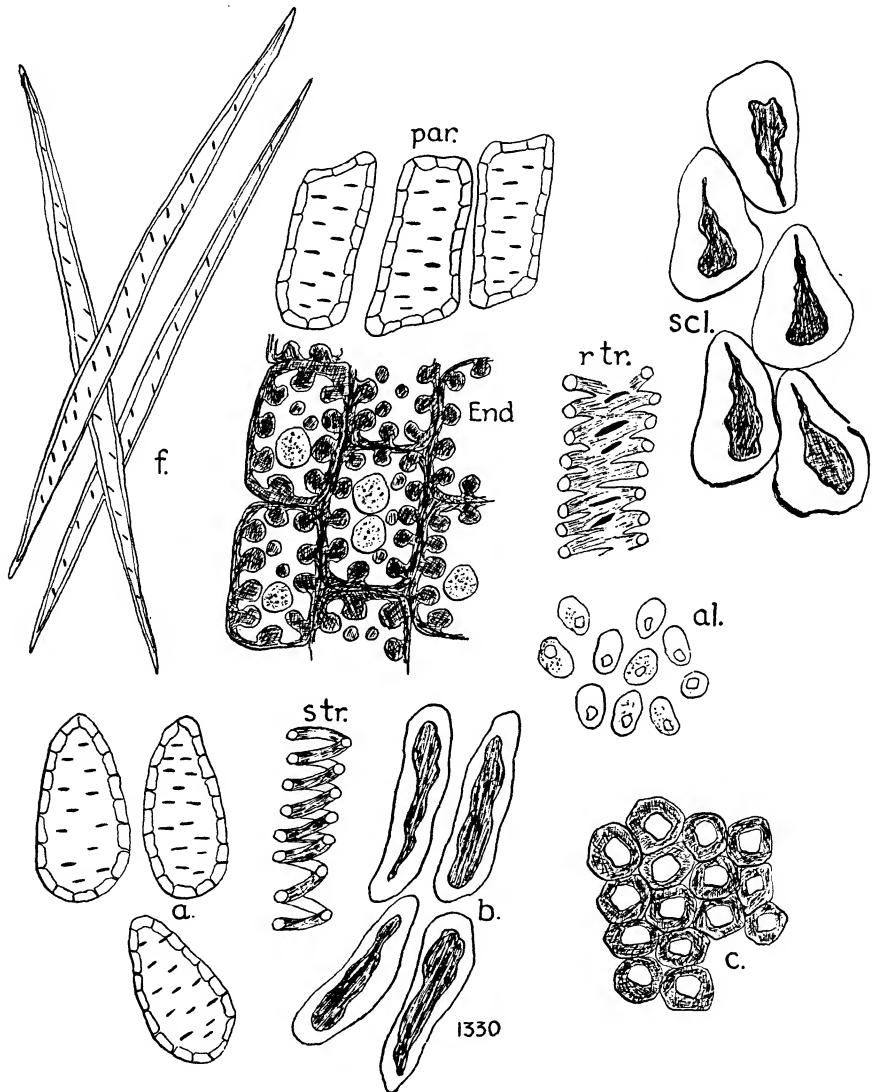


FIG. 60.—Powdered Areca. *End*, endosperm showing beaded and porous walls of reserve cellulose; *al*, aleurone grains; *f*, fibers and *par*, parenchyma cells from adherent mesocarp; *scl*, stone cells from seed coat; *r tr*, reticulate trachea; *str*, spiral trachea thickening; *a*, cells from seed coat; *b*, stone cells; *c*, perisperm tissue.

and dried. They are packed in bags and shipped from Columbo, Ceylon, Padang and Penang to this country.

**Description.**—Seeds rounded-conical, up to 3.5 cm. in length and 3 cm. in diameter; externally weak reddish-brown to light yellowish-brown, marked with

a network of paler lines and frequently showing portions of the silvery endocarp and adhering fibers of the mesocarp adherent at the base. Seed hard, the cut surface showing a marbled appearance from alternating dark brown and whitish tissues (ruminate endosperm); odor slight; taste astringent and slightly bitter.

**Powdered Drug.**—Weak reddish-brown to light brown. Numerous fragments of *endosperm with porous reserve-cellulose walls*; fragments of *brown perisperm with thin walls*; fragments of the *seed coat with irregularly thickened stone cells*; few tracheæ; few aleurone grains from 5 to 40 $\mu$  in diameter and oil globules; *no starch*.

**Constituents.**—From 0.1 to 0.5 per cent. of colorless, oily, liquid alkaloid, *arecoline* ( $C_8H_{13}NO_2$ ), to which the vermifuge properties are attributed, the alkaloids *arecaine*, *guvacine*, *guvacoline* and *arecolidine*; a red tannin compound (*areca red*), and fat.

**Uses.**—Chiefly employed by veterinarians as a vermifuge for dogs and sheep, and by orientals as a masticatory. Source of arecoline.

**Average Dose.**—Dogs, 2-4 Gm. (30-60 grains); sheep, 4-8 Gm. (1-2 dr.). Based on weight of the animal.

**Arecolinæ Hydrobromidum N. F.** ( $C_8H_{13}O_2N.HBr$ ) is the hydrobromide of an alkaloid obtained from the dried ripe seed of *Areca Catechu* L. (Fam. *Palmae*) or produced synthetically. It occurs as a white, crystalline powder or white crystals having a bitter taste. Anthelmintic and myotic. Used for colic in horses and as a taenicide and myotic for humans. Av. dose: Dogs, 1.5 mg. per Kg. ( $\frac{1}{40}$  gr. per pound); Horses, 30 mg. ( $\frac{1}{2}$  gr.), subcutaneously.

### COCOANUT (COCOANUT)

**Plant.**—The Coconut palm (*Cocos nucifera* Linné), also known as the Coco palm and Coconut tree, is the most valuable economic plant of the Palm family. While its habitat has been cited by authorities as the Cocos and Keeling Islands of the Indian Ocean, it is thought by O. F. Cook to be a native of tropical America. It is now found growing along the seacoasts of most tropical countries.

The Coconut is a feather palm with spineless stem, thickened at the base, that rises 40 to 100 feet and bears a terminal crown of pinnate leaves with linear-lanceolate leaflets. The fruit is a large triangular-ovoid drupe with leathery epicarp, broad, fibrous mesocarp and stony endocarp containing a single large albuminous seed.

The most important products of the coconut fruit are the following:

**Coconut.**—The ripe fruit deprived of its husk (epicarp and mesocarp) and so consisting of the seed and stony endocarp to which a number of the mesocarp fibers usually adhere.

**Copra.**—The dried meat of the seed, consisting of the white, fleshy endosperm and small plug-like embryo embedded near its base. Under the microscope, sections of the endosperm show isodiametric to radially-elongated cells with walls about 3  $\mu$ m. thick and contents consisting of needle-shaped



fat crystals and large aleurone grains. The aleurone grains possess a large phytoglobulin.

**Shredded Coconut.**—This product, also known as “desiccated cocoanut,” represents the dried meat reduced to a coarse powder.

**Coconut Oil (Oleum Cocos) N.F.** Synonyms: Coconut Butter. *Fr.* Beurre de Coco. *Ger.* Kokosnussöl. A fixed oil obtained by expression

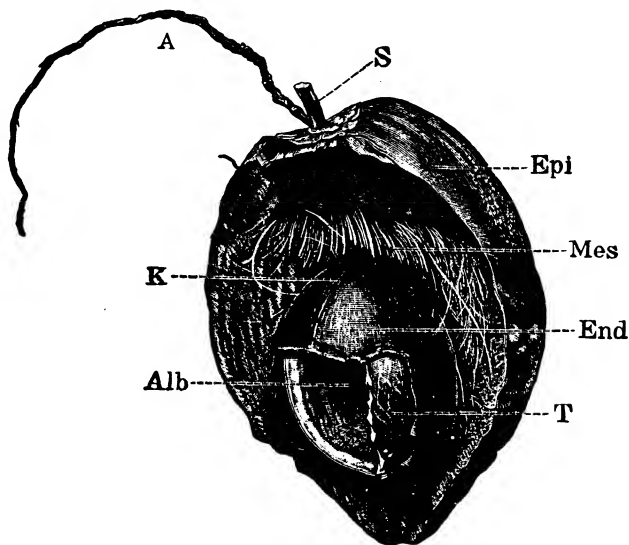


FIG. 61.—Coconut Fruit. A, upper end of axis with scars of male flowers. S, lower part of axis forming the stem. Note the pericarp consisting of *Epi*, epicarp, *Mes*, mesocarp with fibers, and *End*, endocarp; *T*, portion of spermoderm adhering to the “white meat” or endosperm; *Alb*, endosperm surrounding embryo-sac cavity; *K*, germinating eye. (From Winton's “*Microscopy of Vegetable Foods*.” John Wiley and Sons, Inc., the book is permanently out of print.)

or extraction from the kernels of the seeds of *Cocos nucifera* L. Much of the Copra of commerce is shipped to the United States and Europe where the oil is expressed. During 1945, 33,970,820 lbs. of coconut oil were imported into this country from Ceylon, India and British Oceania. In 1947, 26,026,290 lbs. entered the U. S. A. from Philippines, Mexico, China, Canada and Cuba.

Coconut oil is a pale yellow to colorless liquid at 28° to 30°C., becoming semi-solid at 20°C.; hard and somewhat brittle with a characteristic fracture below 15°C.; odor and taste faintly coconut-like or odorless and tasteless; m.p. between 22° and 25°C.; Sp. gr. 0.918–0.923 at 25°C.; ref. ind. 1.4477–1.4495 at 40°C.; saponification value 251–262; iodine value 7–10. It should be preserved in tight, light resistant containers. It must not be used if it has become rancid.

It contains myristic, lauric, oleic, palmitic, stearic and caprylic acids and is employed as a cosmetic, butter substitute, and in the manufacture of soap and shaving creams.

**Coir.**—The fibers of the mesocarp of the coconut fruit. These are used in the manufacture of coconut mats, ropes and as stuffing material. Each fiber represents a fibrovascular bundle.

**Coconut Shells.**—These are obtained as a by-product in the preparation of copra and shredded coconut and have been used in powdered form or as charcoal to adulterate ground spices. Powdered coconut shells, while consisting in the main of stone cells of the endocarp, also contain tissues of the spermoderm and mesocarp. The diagnostic elements include elongated or more or less isodiametric, yellow, thick-walled stone cells with branching pore canals and dark-brown contents, the latter becoming reddish-brown when treated with alkaline solutions, fragments of bast fibers with stegmata, thick walled, porous cells of the seed coat, and spiral, pitted and reticulate tracheæ.

The chief commercial sources of Coconuts are the Philippines, Ceylon and the West Indies.

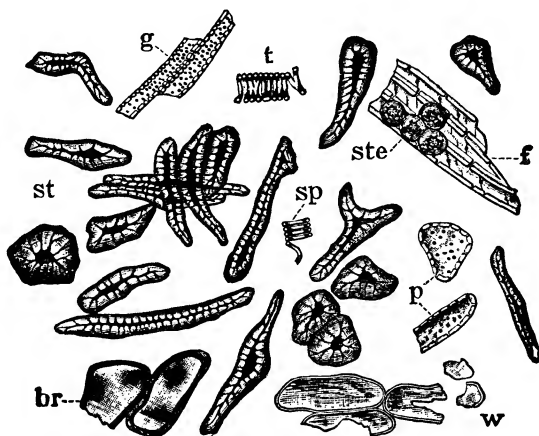


FIG. 62.—Coconut shell elements in powder form. *st*, stone cells with dark yellow walls and brown contents; *g*, pitted trachea; *t*, reticulated trachea; *sp*, spiral trachea; *w*, colorless, and *br*, brown parenchyma of mesocarp; *f*, bast fibers with *ste*, stegmata; *p*, porous cells.  $\times 160$ . (From Winton's "Microscopy of Vegetable Foods," John Wiley & Sons, Inc.)

**Other Economic Products of Palm Family.**—Carnauba Wax is a hard, greenish, brittle wax, melting at  $84^{\circ}\text{C}$ . obtained from the leaf buds of *Copernicia cerifera* (Arruda) Mart., the Brazilian Wax Palm. During 1946, 17,708,538 lbs. of this wax were imported into this country from Brazil. It contains myricyl alcohol (nearly 50 per cent.), myricyl cerotate, ceryl alcohol, cerotic acid, a dihydric alcohol, etc. It is extensively employed as a polish for furniture and in the manufacture of candles.

**Sanguis Draconis** or **Dragon's Blood** is a resin prepared from the scale covering the surface of the ripe fruits of *Dæmonorops Draco* Blume and other species of *Dæmonorops*, climbing palms, native to the East Indies. It occurs as dark red cylindrical sticks up to 3 cm. in diameter and 30 cm. in length which are covered with the leaves of a Licuala palm, bound with strips of cane (*reed dragon's blood*), or in small, dark red, oval, homogeneous masses, covered with dried palm leaves and connected in a row (*tear dragon's blood*) or, as flattened or rounded masses (*lump- or saucer-dragon's blood*). It contains about 56 per cent of a red resin (*dracoresin*) consisting of a mixture of *esters of the resin alcohol*,

*dracoresinotannol*, *benzoic acid* and *benzoylacetic acid*; a white amorphous substance called draco-alban, a yellowish amorphous resene called dracoresene, and vegetable debris. It is used in mahogany varnish stains, for coloring marble red, in incenses, and in preparing gold lacquers.

**Sago** is the starch prepared from the pith of the trunk of species of *Metroxylon*, especially *M. Rumphii* Mart., *M. læve* Mart. and *M. Sagu* Rottboell (Fam. *Palmæ*) and to a lesser extent from species of *Cycas* (Fam. *Cycadaceæ*), growing in the East Indies.

**Pearl Sago** consists of sago meal or starch moistened and warmed until the grains agglutinate and rolled into tiny pellets. It is used as a nutrient. Under the microscope, it shows numerous altered sago starch grains.

**Sago Starch** occurs as ovoid, muller-shaped or irregular 3- or 4-sided grains with rounded angles, simple or 2- to 4-compound, the larger individual grains from 30 to 60 $\mu$ , rarely up to 80 $\mu$  in length, the hilum circular, frequently radiately fissured, eccentric, the lamellæ concentric and eccentric; polarization cross distinct.

**Palm Oil.**—*Elæis guineensis* Jacquin, a West African palm cultivated in tropical America, yields palm oil. Palm oil which is obtained by heating the fruits with water and expressing the oil from the pulp is a fixed oil or solid fat of a yellowish orange, orange-red or dark brown color and possessing a violet odor and a bland taste when fresh. It is harder than butter, bleaches upon exposure to light or heat and rapidly becomes rancid with the development of an acrid taste. It contains glycerides of lignoceric, stearic, palmitic, myristic, oleic and linolic acids. It is used in the preparation of some soaps, candles and ointments.

**Palm Kernel Oil** is a fixed oil or solid fat expressed from the kernels of the seed of *Elæis guineensis*. It is a light yellow to yellowish brown fat of the consistency of butter. It consists chiefly of glycerides of lauric, myristic and oleic acids with small percentages of caproic, caprylic, capric and stearic glycerides. It is used in the manufacture of margarine and soaps.

**Tucum Oil** is a fixed oil obtained from the kernels of the seed of *Astrocaryum vulgare*, a palm native to South America. It possesses a bright red color and an agreeable odor. It is used in soaps and cosmetics.

#### ARACEÆ (AROIDEÆ OR ARUM FAMILY)

Perennial herbs with colorless or milky, acrid or pungent sap and underground stems represented by rhizomes or corms; leaves either alternate or solitary, glabrous, with petiole sheathing at the base and usually swollen, and the blade strongly palmately-, pedately- or peltately-nerved, cordate, or hastate, entire or variously cut. Inflorescence a spadix springing from the axil of the spathe; flowers usually imperfect, sessile and usually crowded on the spathe. Fruit a berry. Seeds with fleshy albumen or filled with a large fleshy embryo. Raphides of calcium oxalate are common in the group. Secretion sacs containing an aromatic oil occur in the genus *Acorus*.

## CALAMUS N.F. (CALAMUS)

**Synonyms.**—*Sweetflag*, Sweet Flag, Sweet Root, Sweet Cinnamon, Sweet Cane, Sweet or Grass Myrtle, Calamus Root, Radix Acori, Radix Calami Aromatici; *Ger.* Kalmus; *Fr.* Acore vrai.

**Botanical Origin.**—*Acorus Calamus* Linné.

**Part Used.**—The peeled, dried rhizome. Calamus intended for extractive preparations may be unpeeled.

**Standard of Assay.**—Not less than 1.2 cc. of volatile oil of calamus from each 100 Gm. of drug.

**Limit of Impurities.**—It contains not more than 1 per cent. of foreign organic matter and yields not more than 6 per cent. of total ash. Peeled Calamus yields not more than 0.5 per cent. of acid-insoluble ash. Unpeeled Calamus yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—On the banks of swamps, streams or ponds of North America, Europe and Asia.

**Plant.**—A perennial herb with a horizontal, aromatic rhizome which gives rise to long, sword-shaped, equitant leaves and scapes. From the upper part of each scape arises a yellowish-green spadix, from the point of insertion of which the scape is prolonged as a spathe.

**Production and Commerce.**—The rhizome system (usually a meter or more in length) is uprooted in the spring from the moist soil, washed, freed of roots, dried at a moderate heat and cut into segments of variable length. During drying it shrinks to about one-half its diameter and loses about 75 per cent. of its weight. In some collecting districts, notably Germany, it is peeled before being dried; but peeled rhizomes should not be employed for the manufacture of preparations, since they are deprived of a portion of the cortex containing a large number of oil cells. The commercial supplies of the drug come from Virginia, Michigan, North Carolina, Indiana, Germany, England, and Russia. Both the peeled and unpeeled articles occur on the market.

**Description.**—Rhizome horizontal; in peeled, subcylindrical, entire or longitudinally split segments, up to 22 cm. long and up to 2 cm. thick; very pale orange to weak yellowish-orange to pinkish-brown or pinkish-white, the upper surface longitudinally furrowed, lower surface with circular, pitted scars of rootlets arranged in irregular, zigzag lines; fracture short, sharp and corky; inner surface whitish or pinkish-white and spongy, showing an elliptical endodermis separating the outer cortex from the central cylinder, both of these regions exhibiting yellowish dots; odor aromatic; taste pungent and bitter.

**Histology.**—Transverse sections of the unpeeled Calamus exhibit an outer epidermis or cork beneath which is to be seen a broad cortex separated from a large central cylinder or stele by an endodermis. The cells of the endodermis possess thin walls and Casparyan spots. The outer region of the cortex consists of collenchyma cells, the inner region of the cortex and all of the pith comprised largely of chains of rounded parenchyma cells surrounding large intercellular-air-spaces. A number of concentric bundles with fibers occur scattered in the cortex. An occasional root trace bundle may also be evident.

Most of the parenchyma cells contain small, spheroidal starch grains, but within each chain of these cells will be noted one or more spheroidal secretion sacs with suberized walls and yellowish-orange volatile oil content. Phlocentric

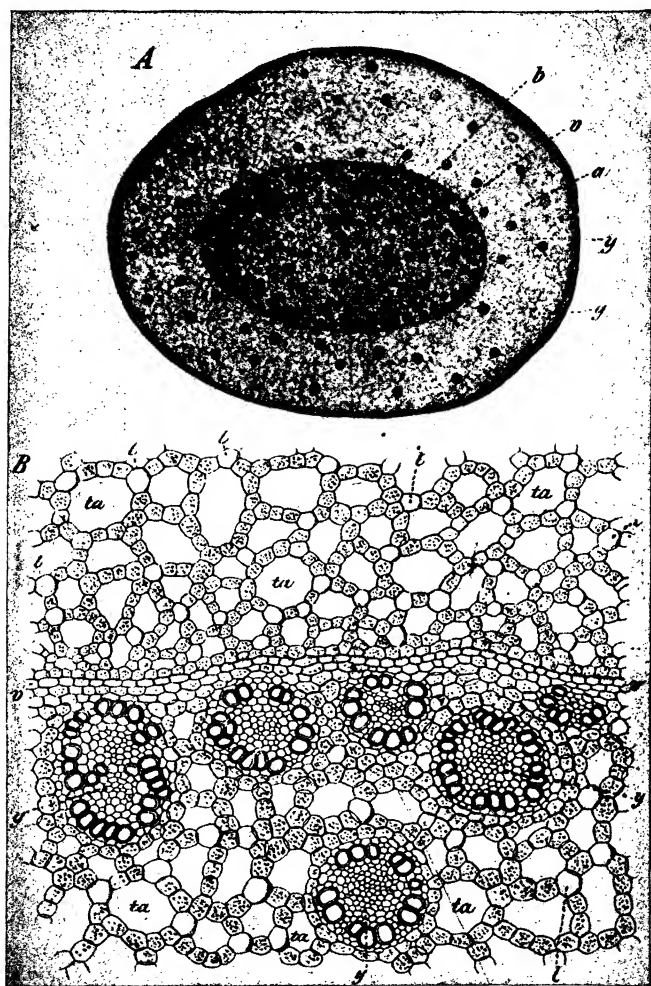


FIG. 63.—Calamus Rhizome. A. Transverse section. B. Portion of a transverse section in the region of the endodermis,  $\times 65$ . a, cortex; b, central cylinder; i, starch parenchyma; l, secretion sacs containing volatile oil; v, endodermis; ta, intercellular-air-spaces; y, concentric fibrovascular bundle of phlocentric type. (After Berg.)

vascular bundles without fibers are scattered throughout the stele and occur more numerous just beneath the endodermis, where they appear crowded.

**Powdered Drug.**—Weak yellowish-orange. Numerous *starch grains*, mostly single, spheroidal from 2 to  $10\mu$ , rarely 2- or 3-compound; tracheæ few, reticulate, scalariform or rarely spiral; few slightly lignified sclerenchyma fibers; occasional fragments of parenchyma with cell contents colored black with ferric chloride

T.S., the walls of some of the parenchyma cells colored purplish-red to reddish-brown with *vanillin-HCl*. Powdered unpeeled Calamus contains *crystal fibers*.

**Constituents.**—*Volatile oil* (1.5 to 3.5 per cent.) containing *asaryl aldehyde*, *eugenol* and *asarone*; a bitter glucoside called *acorin*; soft resin, starch, tannin, etc.

**Uses.**—Carminative, aromatic bitter and stimulant; flavoring agent. Used in atonic dyspepsia and colic.

**Average Dose** (unof.).—3 Gm. (45 grains).

**Adulterants.**—The powdered drug has been adulterated with siliceous earth, ground marshmallow root and cereal flours.

#### LILIACEÆ (LILY FAMILY)

Herbs (*Lilium*), shrubs (*Yucca*), or trees (*Dracena Draco*), with regular and symmetrical almost always six-anded flowers. Stem either short, creeping, underground (*Polygonatum*), or swelling up and forming bulbs (Hyacinth), or corms (*Colchicum*) or stem may elongate above ground and become wiry and herbaceous or semi-shrubby as *Smilax*, or the stem may remain short giving rise to thick, fleshy and sap-storing leaves as in *Aloe*. Leaves linear to lanceolate or ovate, rarely wider, divisible into sheathing base, narrow petiole and expanded blade. Venation parallel, becoming in some ovate leaves parallel with oblique connections, reticulate or highly reticulate, as in *Smilax*, etc. The perianth is parted into six segments, the calyx and corolla being alike in color. Anthers introrse. Ovary three-locular with a single style. Fruit a three-locular, loculicidally dehiscent capsule (*Lilium*, etc.) or rarely a berry (*Asparagus*, *Convallaria*, etc.). Seeds usually numerous, albuminous. Many of the plants contain raphides of calcium oxalate.

#### SQUILL N.F. (SCILLA)

**Synonyms.**—*Scillæ bulbus P.I.*, Sea Onion, Squills, White Squills; *Fr.* Scille; *Ger.* Meerzwiebel.

**Botanical Origin.**—(1) White variety of *Urginea maritima* (Linné) Baker (Mediterranean or White Squill) or (2) *Urginea indica* Kunth (Indian Squill).

**Part Used.**—The cut and dried fleshy inner scale of the bulb.

**Limit of Impurities.**—Not more than 2 per cent of foreign organic matter; it yields not more than 2 per cent of acid-insoluble ash.

**Habitat.**—(1) Mediterranean basin, in sandy and hilly localities; (2) India.

**Plants.**—*Urginea maritima* is a perennial herb whose underground portion consists of a pear-shaped, tunicated bulb, bearing fibrous roots from its base and whose aerial parts consist of a succulent stem bearing a dense raceme of white flowers, in autumn, followed, in the spring, by a rosette of lance-ovate, deep green leaves. The fruit is an oblong, 3-lobed capsule, producing in each cell 6 purplish-brown, flattened seeds. *Urginea indica* resembles the Mediterranean Squill but its tunicated bulb is smaller.

**Production and Commerce.**—Two varieties of Mediterranean Squill occur on the market, the white and red. White Squill, also known as Italian Squill

and Female Squill, is cultivated in Italy, Sicily and Malta. Red Squill is cultivated in Algeria. The former has white or yellowish outer scales, the latter, reddish-brown and rose-colored; the white variety is preferred and is alone official in the N.F. since it imparts little color to preparations. The bulbs, which grow only half immersed in the sandy soil, near the sea, are collected in August, deprived of their dry, membranous outer scales, cut transversely into slices, sun-dried, and packed in casks for shipment. It has been found to adsorb, in its dried condition, as much as 11 per cent. of moisture and, since it is apt to become moldy, should be kept in well-stoppered bottles. The commercial supplies have been imported from Leghorn and Palermo, Italy, from Algeria and France. A quantity of Red Squill is imported for use as rat

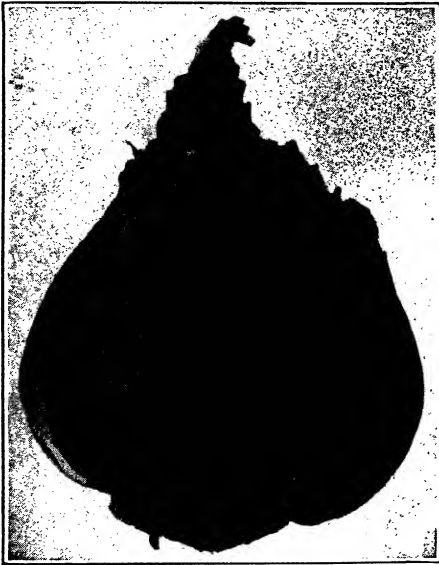


FIG. 64.—Squill bulb,  $\times \frac{1}{3}$ .

poison. During 1947, 628,002 lbs. of red squill were imported into this country from Algeria and Italy. Indian Squill is imported from India.

**Description.**—It occurs on the market as irregular, more or less curved, flattened pieces of fleshy scales (White or Mediterranean Squill) or in more or less shrivelled, curved or sickle-shaped, often longitudinally ridged strips, separated or connected, often several together, to a portion of the shortened axis (Indian Squill); from 0.5 to 5 cm. long, weak yellowish-orange or pale yellow, somewhat translucent; brittle when dry, tough and somewhat flexible when damp; odor slight; taste mucilaginous, bitter, and acrid.

**Histology.**—Epidermis of elongated thin-walled cells and elliptical stomata; mesophyll of slightly elongated, thin-walled cells, many of which contain spheroidal aggregates of a sugar, when examined in alcohol or glycerin mounts. Scattered through the mesophyll are a few concentric fibrovascular bundles, with spiral and reticulate tracheæ and numerous elongated mucilage sacs containing raphides of calcium oxalate of varying length and thickness in different cells. These raphides may attain the length of 1 mm. and serve as the most important diagnostic character of the drug.

**Powdered Drug.**—Yellowish-white to very pale brown; very hygroscopic, tending to cake in a moist atmosphere, and showing, under the microscope, fragments of *thin-walled parenchyma*, a few *spiral and fewer reticulate vessels*, numerous *raphides of calcium oxalate up to 1000 $\mu$  in length* and bundles of these; fragments of epidermis.

**Powdered Red Squill** contains numerous fragments of red, pink or purple epidermis and parenchyma in addition to the other kinds of elements found in white squill.

**Constituents.**—The crystalline glycoside, *Scillaren A*, (Stoll, 1923) ( $C_{36}H_{62}O_{13}$ ), the amorphous glycoside, *Scillaren B* (Stoll, 1923); scillarenase (an enzyme), mucilage, sinistrin, calcium oxalate, a trace of volatile oil, and sugar. Scillaren A is hydrolyzed readily by the enzyme *scillarenase* or by acids to form

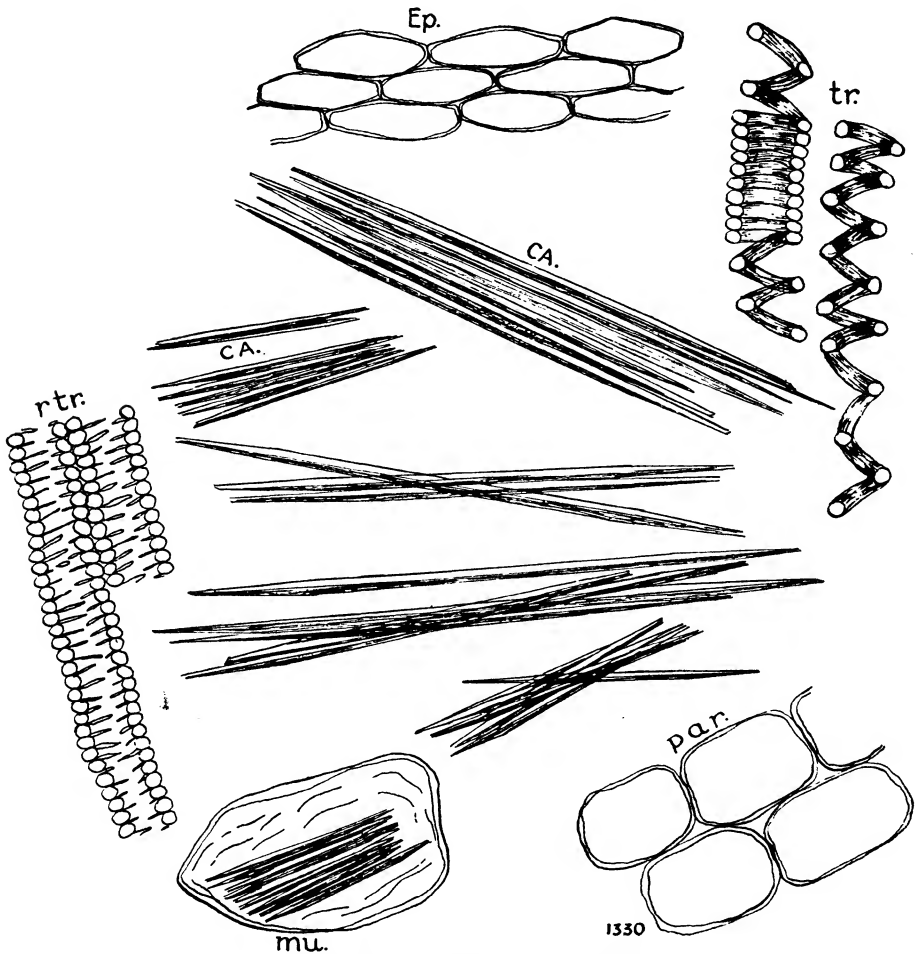


FIG. 65.—Powdered Squill (*Urginea maritima*). *ep*, epidermis; *ca*, raphides of calcium oxalate; *tr*, spiral tracheæ; *r.tr.*, reticulate tracheæ; *par*, mesophyll parenchyma; *mu*, mucilage cell (raphide sac) containing bundle of acicular crystals of calcium oxalate and mucilage. (Drawing by Miss J. Izzo.)

inert scillaridin, rhamnose and glucose. Red squill also contains the specific rodent poison, *scilliroside*.

**Scillaren N.N.R.** is a mixture of squill glycosides in the proportion in which they exist in the fresh crude drug. Cardiac tonic dose, oral, 1.6 mg. ( $\frac{1}{40}$  gr.), 3 to 4 times a day until compensation is effected or until mild toxicity is induced, then in 0.8 mg. doses as required.



**Scillaren-β N.N.R.** is the amorphous component of the natural mixture of glycosides found in squill. It is administered intravenously in threatened cardiac failure in not more than 0.5 mg. dosage within 24 hours.

**Uses.**—Nauseating expectorant, cardiac stimulant and diuretic.

**Average Dose** (unof.).—0.1 Gm. ( $1\frac{1}{2}$  grains).

**Preparations.**—In N.F., Squill Vinegar, Squill Syrup (from Vinegar), 2 cc. (30 minims); Squill Fluidextract, 0.1 cc. ( $1\frac{1}{2}$  minims); Compound Squill Syrup (Hive Syrup), 2 cc. (30 minims); Expectorant Mixture (Mistura Pectoralis) (From Fldext.), 4 cc. (1 fl. dr.).

**Red Squill.**—Red Squill, also known as “Spanish squill” and “male squill,” is the dried bulb of the red variety of *Urginea maritima*. The powdered bulb is used extensively as a raticide and has been found to be a specific poison for the destruction of rats while having little effect upon stock animals and humans. The drug of best quality is that which is oven-dried at 170° to 176°C. When used for the destruction of rats 1 ounce is mixed with a little water to form a paste and added to a pound of ground fresh meat, fish or cereal, the whole being thoroughly mixed as bait. Many small baits have been found more effective than a few large ones.

**Substitutes.**—Bulbs of several *Crinum* species (*Fam. Amaryllidaceæ*) growing in China, East Indies and Brazil. The drug has occasionally been adulterated with small stones.

#### ALLIUM (GARLIC)

**Synonyms.**—English Garlic: *Ger.* Gartenlauch, Knoblauch; *Fr.* Ail.

**Botanical Origin.**—*Allium sativum* Linné.

**Part Used.**—The fresh bulb.

**Habitat.**—Southern Europe. Naturalized and cultivated in the United States.

**Plant.**—A perennial, strong smelling, bulbous herb. Its underground portion consists of a compound bulb with numerous fibrous rootlets. The bulb gives rise above ground to a number of narrow, keeled, grass-like leaves and a stem which rises about a foot and terminates in a simple umbel of purple flowers. The flowers are later replaced by small bulbels.

**Description.**—Garlic occurs as a subglobular, compound bulb composed of from 8 to 15 or more bulblets enveloped by whitish, membranous scales which are attached to a short woody stem, the latter bearing on its under surface many yellowish-white rootlets; bulblets ovoid and 3 to 4 sided with an outer convex surface, each covered with a whitish scale leaf which encloses a thick, whitish fleshy scale within which are 1 to 2 translucent scales and, in the center, 2 or 3 yellowish to yellowish-green foliage leaves, the latter folded together lengthwise; odor, when bruised, strongly alliaceous; taste persistently pungent.

The dry membranous scales, rootlets and shrivelled leaf remnants should be removed before the drug is used in the manufacture of pharmaceutical preparations.

**Constituents.**—Up to 0.9 per cent. of *volatile oil* containing diallyl disulphide and allylpropyl disulphide; the glucoside, *allin*, which is hydrolyzed by the enzyme, *allisin*, to form volatile oil and fructose.

**Uses.**—Garlic is chiefly used in the form of the syrup as a diaphoretic, diuretic and expectorant. It is also employed as a poultice in bronchitis and as a seasoning agent.

**Average Dose.**—2 Gm. (30 grains).

**Product.**—**Garlic Powder** is ground, dehydrated garlic. It is a creamy white powder with a persistent, strong garlic odor and taste. It is used by the sausage and meat packing industry as a flavoring agent for their products and also in the preparation of Garlic Salt.

#### VERATRUM VIRIDE N.F. (VERATRUM VIRIDE)

**Synonyms.**—*American Hellebore*, *Green Hellebore*, Swamp Hellebore, Indian Poke. *Ger.* Grüner Germer; *Fr.* Vêratre vert.

**Botanical Origin.**—*Veratrum viride* Aiton.

**Parts Used.**—The dried rhizome and roots.

**Limit of Impurities.**—5 per cent. of its stems or other foreign organic matter and 4 per cent. of acid-insoluble ash.

**Habitat.**—In rich, wet woods, moist meadows, and swamps of Eastern Canada and Eastern and Central United States.

**Plant.**—A perennial herb with a stout stem 2 to 8 ft. in height, bearing oblong-ovate, acuminate, sheathing, prominently parallel veined leaves below, and terminating in a panicle of dense spike-like racemes of yellowish-green flowers. The fruit is a 3-celled, many-seeded capsule.

**Commercial.**—The rhizome and roots are dug in early summer, washed, usually cut into 2 to 4 longitudinal pieces and carefully dried. The chief sources of supply of this drug are Michigan, Illinois, North Carolina and Virginia.

**Description.**—Rhizome erect, obconical, generally in the form of longitudinal slices from 2 to 7 cm. in length and from 1.4 to 3 cm. in diameter, externally brownish-gray or brown, often crowned with closely arranged leaf bases, somewhat annulate from scars of bud scales and bearing along the outer surface numerous *transversely wrinkled rootlets*; fracture of rhizome hard and horny; internally grayish-white, showing numerous scattered fibrovascular bundles; roots numerous, weak brown to weak yellowish orange, subcylindrical, 1 to 4 mm. in diameter; *fracture, brittle*, exhibiting a *whitish starchy interior*; without odor but sternutatory; taste bitter and acrid.

**Histology.**—Transverse sections of the **rhizome** exhibit the following structures, passing from periphery toward the center: (Fig. 66A)

1. *Epidermis* of an outer layer of reddish-brown to yellowish-orange cork-like cells.

2. *Cortex*, a moderately broad zone composed of a matrix of parenchyma, the cells of which are rounded, more or less isodiametric and pitted. Most of the cells contain spherical or ellipsoidal, single or 2- to 3-compound starch

grains, a lesser number, raphides of calcium oxalate, up to  $150\mu$  in length. Coursing outward through this region will be noted occasional root trace bundles on their way to the rootlets, and in the upper region, leaf trace bundles.

3. *Endodermis*, a somewhat wavy layer of somewhat lignified cells, becoming 2 layered in parts, the inner and radial walls being more thickened than the

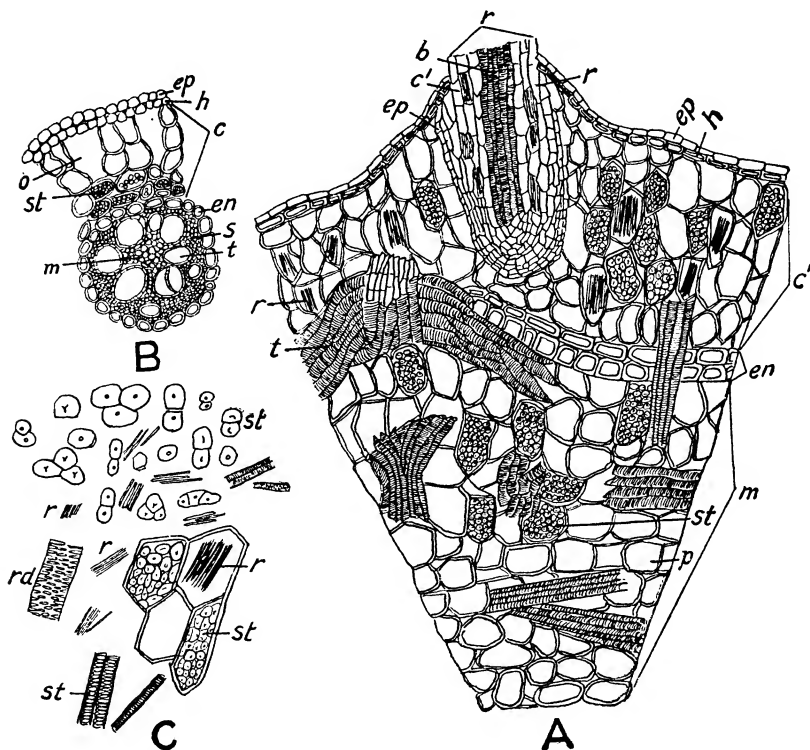


FIG. 66.—*Veratrum Viride*. A. Rhizome as observed in cross-section showing outgrowth of lateral rootlet (r); epidermis (ep); hypodermis (h); cortex (c); endodermis (en); pith (m); bundle of root (b); raphides in cells (r); starch (st); parenchyma (p); and tracheæ (t). B. Root (diagrammatic) in cross-section showing epidermis (ep); hypodermis (h); oxygen chamber (o); starch parenchyma (st); endodermis (en); pith (m); sieve tissue (s) and tracheæ (t) of a radial fibrovascular bundle. C. Elements of powdered drug. Starch grains (st); raphides of calcium oxalate (r); reticulate duct (rd); and spiral ducts (st at lower left).

outer wall, the U-shaped lumen being about one-half the width of the cell. The endodermis is broken in places by *root-trace* or *leaf-trace bundles*.

4. *Stele*, a broad parenchyma zone with cells resembling those of the cortex and showing fibro-vascular bundles arranged in irregular interrupted circles or scattered.

Transverse sections of the root present the following structure: (See Figs. 67 and 68).

1. *Epidermis* of more or less quadrangular cells with lignified and thickened outer and radial walls.

2. *Hypodermis* of a layer of more or less compressed cells, beneath which are two to three layers of collenchyma.

3. *Aerenchyma*, consisting of large, irregular air-spaces surrounded by parenchyma cells in the outer cortex.

4. *Cortical parenchyma*, a broad zone of spherical cells which become gradually smaller toward the central cylinder. Most of the cells contain spherical or ellipsoidal, single or 2- to 3-compound starch grains; a number contain raphides of calcium oxalate.

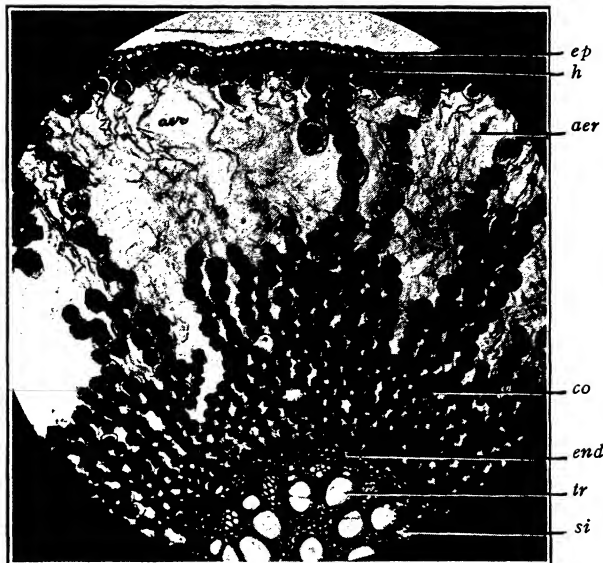


FIG. 67.—*Veratrum Viride* Root. Photomicrograph of a representative portion of a cross section. *ep*, epidermis; *h*, hypodermis; *aer*, aerenchyma; *co*, cortex; *end*, endodermis; *tr*, trachea of xylem; *si*, sieve tubes.

5. *Endodermis*, consisting of a layer of endodermal cells with slightly lignified inner and radial walls and with U-shaped lumen about one-third to one-half the cell width.

6. *Pericambium* of a layer or two of meristematic cells.

7. *Radial Fibrovascular Bundle* of many alternating xylem and phloem patches.

8. *Pith*, a small central zone of starch and calcium oxalate containing parenchyma.

**Powdered Drug.**—The powder varies in color from pale brown to pale olive. It is strongly sternutatory. When examined under the microscope the following histological elements are exhibited: Raphides of calcium oxalate from  $15\mu$  to  $150\mu$  in length; numerous spheroidal or ellipsoidal starch grains from  $3\mu$  to  $20\mu$  in diameter, single or 2- to 3-compound; fragments of scalariform and reticulate tracheæ often with yellowish contents and associated with slightly lignified sclerenchyma fibers; fragments of reddish-brown to brownish-black suberous tissue, and many parenchyma cells or the walls thereof.

**Constituents.**—The alkaloids *cevadine*, *veratridine*, *jervine*, *pseudojervine*, *rubijervine*, *germerine*, *germidine*, and *germitrine*, the last three ester alkaloids of the base *germine* ( $C_{26}H_{41}O_3N$ ); jervic acid, acrid resin, fat, gum, and starch.

**Uses.**—Cardiac, respiratory and vaso-motor depressant. *Veratrum* is used to slow an overactive heart, as in auricular fibrillation, reduce high blood pressure in arteriosclerosis, interstitial nephritis, threatened apoplexy, in puerperal eclampsia, and to lower the pulse rate in tachycardia. The powdered drug is used as an insecticide.

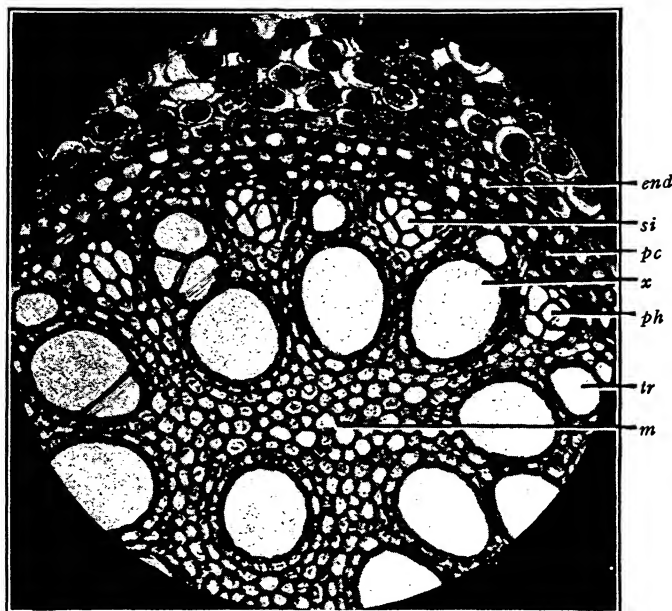


FIG. 68.—*Veratrum Viride* Root. Photomicrograph of central region of cross section. Highly magnified. *end*, endodermis; *pc*, pericambium; *si*, sieve tubes; *ph*, phloem; *x*, xylem region; *tr*, trachea; *m*, pith. Several layers of cortex will be noted outside of endodermis.

**Average Dose.**—0.1 Gm. ( $1\frac{1}{2}$  grains).

**Preparations.**—*Veratrum Viride* Tincture (*Tinctura Veratri Viridis*) N.F., 1 cc. (15 minims). *Vertavis* is a biologically standardized powdered *Veratrum Viride*, supplied in tablets.

**Poisoning.**—The symptoms of *veratrum* poisoning are vomiting, retching, great muscular weakness and prostration. The pulse is at first slow but becomes rapid and irregular in severe cases, the skin covered with perspiration, the respirations shallow. Treatment consists of keeping the patient from the start in a horizontal position, evacuating the stomach, administering activated charcoal and, if in early stage, atropine to stimulate respiratory center; external application of heat may be necessary to maintain body temperature.

**Substitutes.**—The rhizome and roots of *Helleborus niger* L. or Christmas Rose (Fam. *Ranunculaceæ*) have appeared on the market under the label "American Hellebore." This drug is a powerful cardiac stimulant, having a therapeutic action just opposite to that of *Veratrum Viride*. It can be readily detected

by the grayish-black, knotty, external appearance of the rhizome, its dicotyledonous internal structure and its absence of raphides of calcium oxalate.

**Adulterants.**—Rhizomes and roots of European or White Hellebore, *Veratrum album* Linné; rhizomes and roots of Skunk Cabbage, *Symplocarpus fœtidus* Salisbury, the latter plant being abundant in localities where *Veratrum viride* grows. *Veratrum album* is indigenous to mountainous regions of Europe. Its rhizome and roots closely resemble those of *V. viride*, but the thickening on the radial and inner walls of the endodermal cells appears to be more pronounced in the specimens examined, the lumen of the endodermal cells of the rootlets being usually characteristically V-shaped, and the oxygen spaces in the aerenchyma of the rootlets appearing less pronounced. **White Hellebore** contains the alkaloids *protoveratrine*, *protoveratridine*, *germerine*, *jervine*, *pseudojervine* and *rubijervine*. In powdered form it is employed as an insecticide.

Concentrated sulfuric acid, when first applied and immediately observed, colors the powder or sections of *V. album*, an orange or dull red, whereas material of *V. viride* take a yellowish color. In both the color quickly changes to red followed by reddish-brown. *Symplocarpus fœtidus* is indigenous to localities where *Veratrum viride* abounds. Like the latter its rhizome is erect, shows leaf remnants at its upper end and numerous long, deeply wrinkled rootlets attached, but it can readily be distinguished from *Veratrum* by its fetid odor, upon triturating or warming, and by its pungent taste.

#### SABADILLA (CEVADILLA)

**Synonyms.**—Sabadilla Seed, Indian Barely Caustic.

**Botanical Origin.**—*Schoenocaulon officinale* (Chamisso and Schlechtendahl)

A. Gray ex Benthām [*Asagraea officinalis* (Chamisso and Schlechtendahl) Lindley].

**Part Used.**—The dried seeds.

**Habitat.**—Costa Rica, El Salvador, Guatemala, Honduras, Venezuela and Peru, in mountains.

**Plant.**—A bulbous herb with a 3-celled, papery capsule, each cell of which contains 1 to 6 albuminous seeds.

**Commercial Source.**—South America.

**Description.**—Sabadilla occurs as a mixture of loose seed with papery capsules. Seeds brownish-black, narrowly oblong to lance-linear, somewhat curved, angular, with a beak at one end, rounded at the other, 5 to 8 mm. in length and up to 2 mm. in thickness; testa wrinkled and thin; internally showing a whitish, oily albumen with a small, linear embryo at the rounded, basal end; odor indistinct; taste bitter and acrid. The powdered drug is sternutatory.

**Constituents.**—The alkaloids *cevadine*, *veratridine*, *sabadinine* (*cevine*), *sabadine* and *cevadilline*, cevadic, veratric, angelic and methylcrotonic acids, fixed oil, etc.

**Uses.**—As a source of Veratrina which is a mixture of all of the alkaloids of Sabadilla seed. Externally in liquid or ointment preparations as a parasiticide for lice and vermin.

**Sabadilla dusts** containing from 10 to 20 per cent of powdered sabadilla seed are effective insecticides against squash bugs, chinch bugs, lygus bugs and harlequin bugs, leaf hoppers and cattle lice. Treatment of sabadilla seed with heat (75°C.) for four hours before powdering with a diluent such as talcum or sulfur increases its toxic efficiency. Activation can also be accomplished by alkali treatment such as using powdered hydrated lime as a diluent in the dust.

Veratrine has been employed chiefly as an anodyne counter-irritant in neuralgia and arthritis in the form of the oleate.

**Average Dose of Veratrine.**—0.002 Gm. ( $\frac{1}{30}$  grain).

COLCHICUM CORM N.F. (COLCHICI CORMUS)

**Synonyms.**—Colchicum-root, Meadow Saffron Corm, Purple-, Autumn- or Meadow-Crocus; *Ger.* Wiesensafran, Zeitlosenknollen; *Fr.* Bulbe de Colchique.



FIG. 69.—*Colchicum autumnale*, as growing in the Harvard University Botanic Garden, October, 1929. The flowers have developed from young corms.

**Botanical Origin.**—*Colchicum autumnale* Linné.

**Part used.**—The dried corm.

**Standard of Assay.**—Not less than 0.35 per cent. of anhydrous colchicine.

**Acid-insoluble Ash.**—Not more than 0.5 per cent.

**Habitat.**—In meadows and pastures of Central and Southern Europe and Northern Africa.

**Plant.**—A perennial herb with a habit somewhat like the Tulip. The underground portion consists of an ovoid corm which is convex on one side and somewhat flattened with a groove on the other side. From this there first arises, in autumn of the first year, two to six long-tubed, lilac-purple flowers, the peduncles and lower portion of corolla tubes being surrounded by a spathe. In the spring of the second year there arise 3–5 dark green, long, lance-ovate shaped leaves and a 3-valved septicidally-dehiscent capsule containing many subglobular, small brownish seeds. A new corm is formed each year in the axil of a scale leaf on the lateral inferior surface of the old one, near its base. The daughter corm is lodged in an infolding in the side of the parent corm and produces flowers in the fall of the first year.

**Cultivation.**—Colchicum may be propagated from daughter corms or from seed. Unless the seed is sown as soon as the capsules dehisce, germination will be delayed from 1 to 5 years, depending upon the time the seed has been kept in the dried condition before planting. The fresher the seed the greater its percentage of viability. The seed is sown in a cold frame or directly in the field in garden soil containing some lime. The ground should be kept constantly moist during the germination period. The plants should be transplanted at the end of the second year and set 3 to 6 in. apart in moist soil. The corms

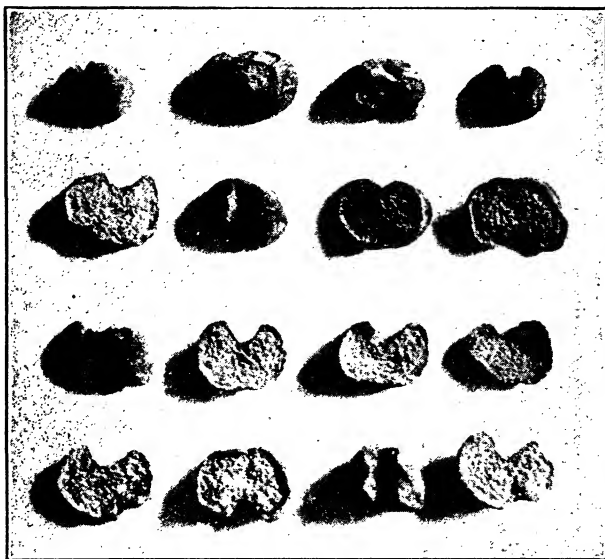


FIG. 70.—Colchicum Corm. Note the prevailing reniform slices of the corm. The groove, shown in both transverse and longitudinal view, is formed by the growing flower stem of the daughter corm.  $\times \frac{3}{4}$ .

should be planted in July or August and set 3 in. deep and spaced at least 3 in. apart.

**Production and Commerce.**—The year-old corms have been found to contain the maximum amount of colchicine (active principle). These are dug up after the death of the foliage leaves and before the flowering of the daughter plant, which varies in different latitudes from July to the end of October. The outer brown membranes and rootlets are removed and the corms usually sliced transversely and dried by the sun or in ovens. Most of the supply comes in bags from Leghorn and Trieste, Italy, from Hungary, Yugoslavia, and Amsterdam, Holland.

**Description.**—In transverse and longitudinal slices, the transverse slices being reniform in shape, the longitudinal, ovate; from 2 to 5 mm. in thickness; flat surfaces yellowish-white to pale yellowish-orange and of a crystalline appearance under a simple microscope; epidermal surface pale brown to dusky yellowish-orange and wrinkled; fracture short and mealy; odor indistinct; taste starchy, bitter and acrid.



**Powdered Drug.**—Weak yellowish-orange. Starch grains numerous, single or 2- to 6-compound; the individual grains varying from spherical or ovoid to polygonal, up to  $30\mu$  in diameter, and exhibiting a triangular or stellate central hilum; fragments of epidermis with thin, reddish-brown walls; tracheæ few with

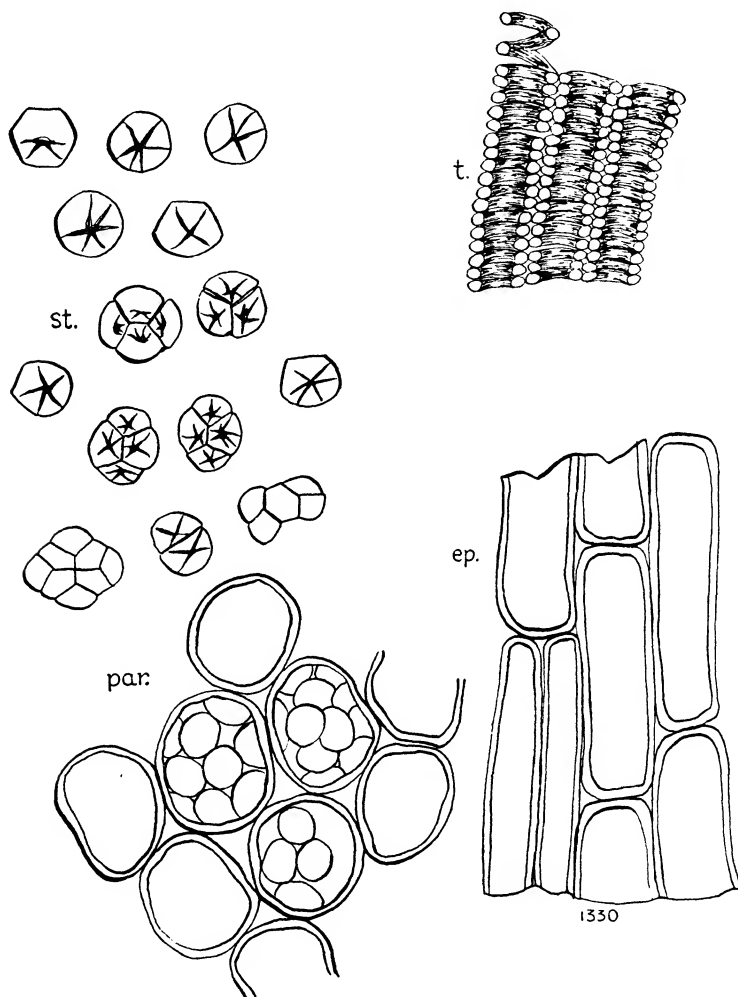


FIG. 71.—Powdered *Colchicum Corm.* *st.*, simple and compound starch grains; *t.*, spiral tracheæ; *ep.*, epidermis; *par.*, starch- and alkaloid-bearing parenchyma. (Drawing by Miss J. Izzo.)

spiral or scalariform markings. Sulfuric acid colors the powder reddish-yellow; due to the presence of colchicine.

**Constituents.**—The amorphous alkaloid *colchicine* ( $C_{22}H_{22}O_6N$ ) 0.25 to 0.6 per cent.; starch. Colchicine also occurs in *Gloriosa superba* and in *Androcymbium gramineum*, both members of the *Liliaceæ*. The latter, a native of the

southern Sahara district of Africa contains up to 0.37 per cent. of colchicine in its bulbs and 0.29 per cent. in its seeds.

**Uses.**—Antirheumatic in acute gout.

**Average Dose** (unof.).—0.25 Gm. (4 grains).

**Preparations.**—Colchicum Corm Fluidextract, 0.25 cc. (4 minims); Strong Colchicum Corm Tincture (from Fldext.), 0.6 cc. (10 minims).

#### COLCHICUM SEED N.F. (COLCHICI SEMEN)

**Synonyms.**—Meadow Saffron Seed, *Colchici Semen P.I.*; *Ger. Zeitlosensamen*; *Fr. Semences de Colchique*.

**Botanical Origin.**—*Colchicum autumnale* L.

**Part Used.**—The dried ripe seed.

**Standard of Assay.**—Not less than 0.45 per cent. of colchicine.

**Limit of Impurities.**—Not more than 1 per cent of foreign organic matter; not more than 1 per cent of acid-insoluble ash.

**Commercial.**—The seeds are collected from the capsules in late summer or early autumn and should be carefully dried. Some supplies have been imported in a moist condition. They are shipped to this country from Holland, Italy, Yugoslavia and Hungary.

**Description.**—Seeds albuminous, ovoid or irregularly globular, amphitropous, minutely pointed at the hilum, with a beak or caruncle opposite the hilum; from 2 to 3 mm. in diameter; externally weak reddish-brown to dark brown, finely pitted; of almost bony hardness; internally pale yellow, yellowish-gray or light brown; nearly inodorous; taste bitter and acrid.

**Histology.**—Transverse sections show a spermoderm of several layers of somewhat collapsed cells with thin, reddish-brown, orange or olive brown walls; the endosperm taking up most of the room within the seed coat and consisting of thick-walled, porous, reserve parenchyma cells which contain oil globules and aleurone grains, the latter varying from 3 to 15  $\mu$  in diameter; a small embryo embedded in the endosperm. The beak or caruncle of the seed, when sectioned, shows parenchyma cells containing numerous ovoid, ellipsoidal or polygonal starch grains from 5  $\mu$  to 20  $\mu$  in diameter.

**Constituents.**—*Colchicine* ( $C_{22}H_{25}NO_6$ ) 0.4 to 0.6 per cent., colchicoresin, tannin, fixed oil, starch, etc.

**Uses.**—To relieve pain and swelling of the joints in gout; source of colchicine. Large therapeutic doses of colchicum act as a gastro-intestinal irritant, producing nausea, vomiting and diarrhea.

**Average Dose** (unof.).—0.2 Gm. (3 grains).

**Preparations.**—Colchicum Seed Tincture N.F. 2 cc. (30 minims). Colchicum Seed Fluidextract N.F. 0.2 cc. (3 minims).

#### COLCHICINE U.S.P. (COLCHICINA)

Colchicine is an extremely poisonous alkaloid obtained from *Colchicum autumnale* L. (Fam. *Liliaceæ*). It occurs in pale yellow, odorless, amorphous

scales or powder and darkens on exposure to light. 1 Gm. dissolves in 25 cc. of water forming a yellow solution which is lævorotatory. Colchicine is freely soluble in alcohol and chloroform.

**Identity Test.**—One drop of ferric chloride T.S. added to 1 cc. of a 1:20 alcoholic solution of colchicine produces a garnet red color at once.



FIG. 72.—Mexican Sarsaparilla (to right); Jamaica Sarsaparilla (in center); Honduras Sarsaparilla (to left).

**Uses.**—In the treatment of acute gout; in genetics and plant breeding to produce doubling of the chromosomes. Colchicine is a specific for chromosome separation. The chief preparations of colchicine used by geneticists are a 0.4 per cent Lanolin emulsion and a 0.1 per cent aqueous solution.

**Average Dose.**—0.5 mg. ( $\frac{1}{20}$  grain).

**Preparation.**—Colchicine Tablets U.S.P.

#### SARSAPARILLA U.S.P. (SARSAPARILLA)

**Synonyms.**—(1) Mexican, Vera Cruz, Tampico or Gray Sarsaparilla; (2) Honduras or Brown Sarsaparilla; (3) Ecuadorian Sarsaparilla; (4) Central

American, Jamaica, Costa Rica, Lima or Red Sarsaparilla; *Ger.* Sarsaparill-wurzel; *Fr.* Racine de Salsepareille.

**Botanical Origin.**—(1) *Smilax aristolochiaefolia* Miller (*Smilax medica* Chamisso and Schlechtendal); (2) *Smilax Regelii* Killip and Morton; (3) *Smilax febrifuga* and undetermined species of *Smilax* respectively known in commerce as Ecuadorian and Central American Sarsaparilla.

**Part Used.**—The dried root.

**Purity Rubric.**—It contains not more than 2 per cent. of foreign organic matter, other than the rhizome and crown portion. The Mexican and Ecuadorian Sarsaparillas contain not more than 10 per cent. of rhizome and aerial stem portions. Mexican Sarsaparilla yields not more than 4 per cent. of acid-insoluble ash. The other varieties yield not more than 2 per cent. of their weight of acid-insoluble ash.

**Habitat.**—Tropical America. Mexico to Brazil and Ecuador.

**Plants.**—Climbing evergreen shrubs with prickly stems. The leaves are alternate, coriaceous, petiolate, ovate to oblong, 5- to 7-nerved and reticulately veined between the nerves, with a cordate, hastate or rounded base and stipules modified as tendrils. They are usually armed on the principal veins beneath with spines. The flowers occur in axillary umbels. The fruit is a small, globular berry.

*Smilax aristolochiaefolia* [*S. medica* Schlecht & Cham.; *S. ornata* Lem.; *S. kerberi* Apt.] is native to Mexico and the Yucatan Peninsula. *S. Regelii* (*S. ornata* Hook.) is native to northern Central America. Both of these species belong to the Section *Medicæ* of the genus *Smilax* which is characterized by possessing lower stems which are sharply or obtusely quadrangular, by the lower leaves being usually cordate or hastate at base and often aculeate and by the petiole being articulate above the middle of the free part. *S. aristolochiaefolia* may be distinguished from *S. Regelii* by possessing red berries, perianth segments 3.5 to 4 mm. in length, 6 staminodes in its pistillate flowers, obtusely quadrangular lower stems and subterete upper stems whereas the latter species possesses black berries (or white in the var. *albida* Killip and Morton), all of its stems sharply quadrangular, and its perianth segments are 3.5 to 5 mm. in length. A specimen of plant yielding some of the commercial Ecuadorian Sarsaparilla and forwarded by a correspondent in Chimbo, Ecuador, was determined as *Smilax febrifuga*.

**Commercial.**—There are four commercial varieties of Sarsaparilla on the American market, namely: Mexican, Honduras, Ecuadorian and Central American or Jamaica.

Mexican Sarsaparilla is exported to this country either as rhizomes and roots or as roots, only, from Tampico, Mexico City and Vera Cruz. It is frequently imported in large bales bound with wire. Honduras Sarsaparilla is shipped from Puerto Cortez and Santa Barbara, British Honduras, packed in burlap, with the ends protected by green hides which are sewed on to the end of the package. Each package contains a number of cylindrical rolls bound firmly and closely around with roots of the same plant. Ecuadorian Sarsaparilla is exported as

rhizomes and roots from Guayaquil, Ecuador. Some supplies of this variety are gathered in the vicinity of Chimbo, Ecuador. Central American or Jamaica Sarsaparilla is imported from Costa Rica through Guatemala or Panama in bales. This variety should not be confused with the Native Jamaica Sarsaparilla which is cultivated on the island of Jamaica and whose endodermal and hypodermal cells show thickenings very similar to the Mexican variety.

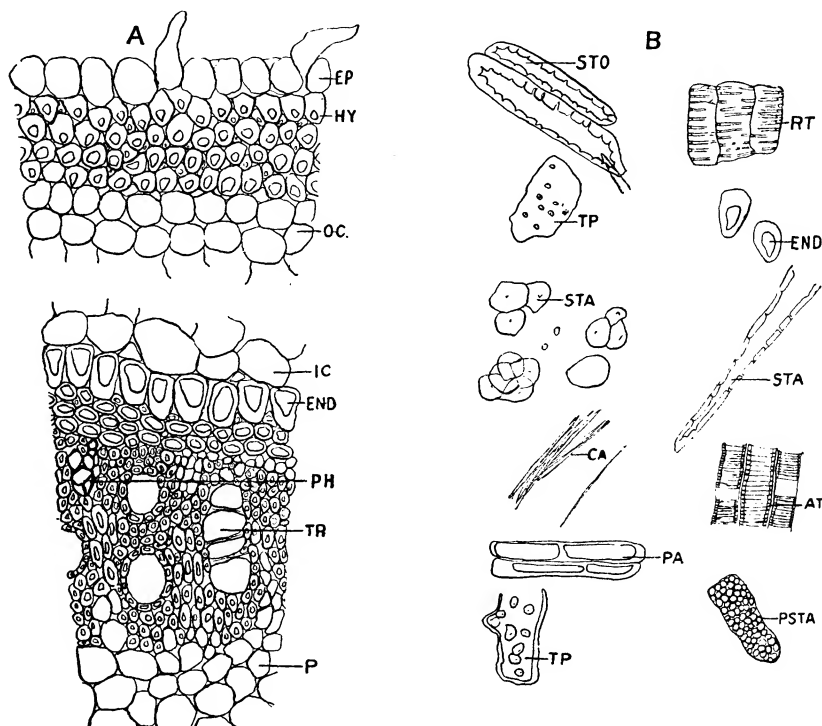


FIG. 73.—Mexican Sarsaparilla. A. Transverse section, showing epidermis and 2 root hairs (ep); hypodermis (hy); outer cortex (oc); inner cortex (ic); endodermis with radial and inner walls thicker than outer walls (end); phloem (ph); tracheae (tr) and pith (p). B. Powdered Sarsaparilla. Reticulate tracheae (rt); fragment of trachea with simple pores (tp); stone cells from stem (sto); sclerenchyma fiber (sta on right); starch (sta on left); raphides of calcium oxalate (ca); parenchyma cell with starch content (psta); annular tracheae (at); endodermal cells (end); parenchyma (pa).

**Description.**—Sarsaparilla is nearly odorless. Its taste is mucilaginous, somewhat sweetish and acrid. The unground official varieties are as follows:

**Mexican Sarsaparilla.**—In long roots up to 6 mm. in diameter, frequently attached to a tough, woody crown possessing one or more stem bases; externally light grayish-brown or weak reddish-brown to yellowish-brown, longitudinally ridged and broadly furrowed, the furrows sometimes containing blackish earth; with relatively few fibrous rootlets; fracture of cortex brittle, of central cylinder tough and fibrous; the cut or fractured surface exhibiting a mealy and pale orange, or light yellowish brown and horny cortex, a yellow and porous woody zone and a lighter colored central pith.

**Ecuadorian Sarsaparilla.**—Roots long, from 2 to 6 mm. in diameter, frequently attached to a crown having one or more stout purplish stems; externally reddish-brown to purplish, longitudinally wrinkled or furrowed with occasional fibrous rootlets; fracture of cortex short to fibrous, of central cylinder tough and fibrous; cortex brown to reddish-brown, the woody central cylinder yellowish-brown and porous; pith white

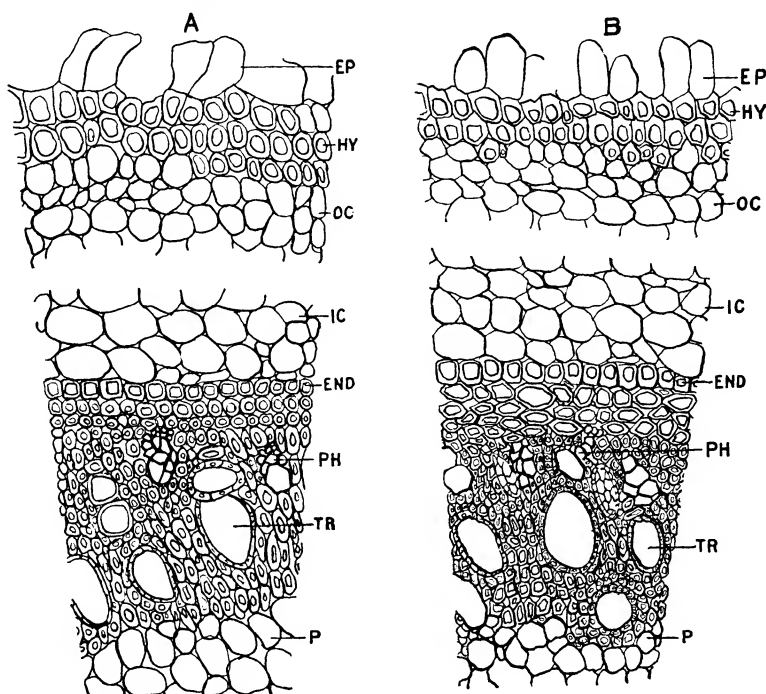


FIG. 74.—A, Honduras Sarsaparilla. Transverse section of root. Epidermis (ep); hypodermis (hy); outer cortex (oc); inner cortex (ic); endodermis (end); phloem (ph); trachea of xylem (tr) flanked by thick-walled wood fibers; pith (p). B, Native Jamaica Sarsaparilla. Transverse section of root. Epidermis (ep); hypodermis (hy); outer cortex (oc); inner cortex (ic); endodermis (end); phloem (ph); trachea of xylem (tr); pith (p).

**Honduras Sarsaparilla.**—In long roots from 2 to 5 mm., rarely 6 mm. in diameter, often folded and bound together by roots of the same plant into compact cylindrical bundles; externally dark brown or reddish-brown, longitudinally wrinkled or finely furrowed with occasional fibrous rootlets; fracture short, sometimes tough and fibrous in central cylinder; internally, the cut surface showing a moderate brown to yellowish-orange cortex, a light yellow and porous woody zone and a lighter colored pith.

**Central American Sarsaparilla.**—Roots long, from 1 to 4, rarely 5 mm. in diameter; externally moderate yellowish-brown to usually weak reddish-brown, longitudinally wrinkled, rarely furrowed, occasionally nearly smooth, and bearing numerous coarse fibrous rootlets; fracture short, or tough and fibrous in the central cylinder; internally the cut surface showing a white or brown cortex, a yellow porous woody zone and a yellow or grayish-white starchy pith.

**Powdered Drug.**—Pale brown to weak yellowish-orange. Starch grains numerous, single or 2- to 4-compound, the individual grains from  $3\mu$  to  $23\mu$  in diameter, spheroidal, biconvex or spherical-tetrahedral, frequently exhibiting

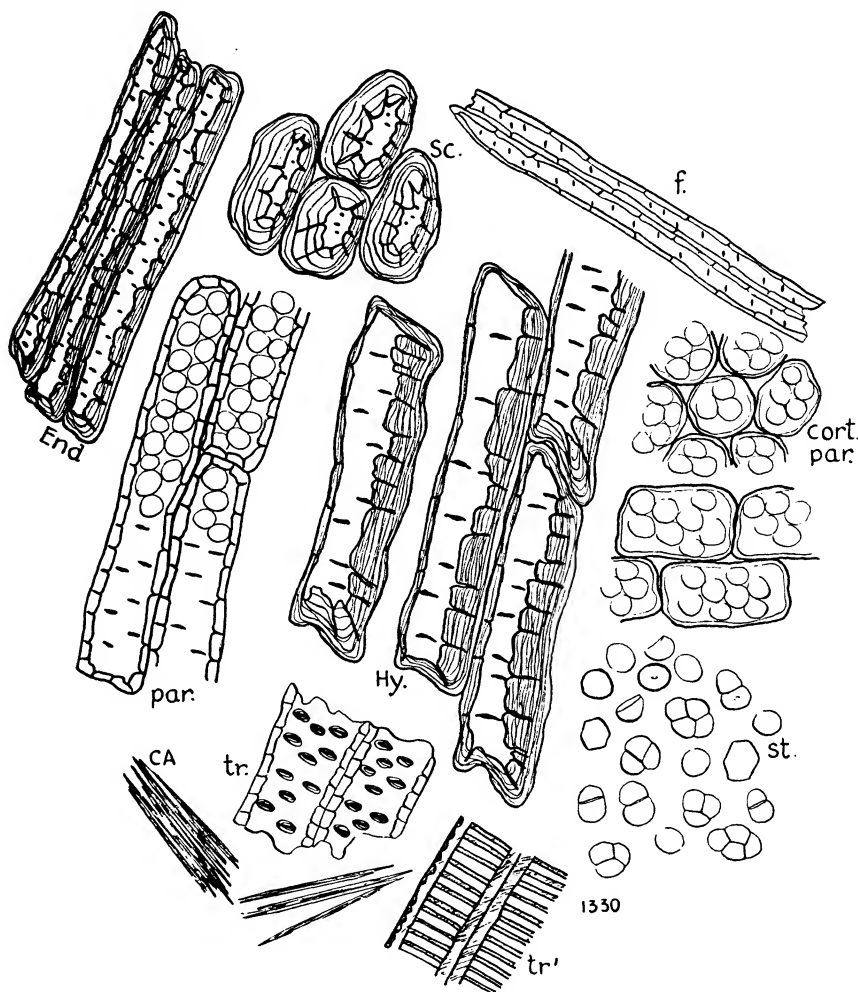


FIG. 75.—Powdered Mexican Sarsaparilla. *end*, endodermal cells; *sc*, stone cells from woody crown; *f*, wood fibers, *par.*, wood parenchyma; *hy*, hypodermal cells; *cort. par.*, cortical parenchyma; *st*, starch grains; *ca*, raphides of calcium oxalate; *tr*, tracheae with bordered pores; *tr'*, scalariform tracheae. (Drawing by Izzo.)

a central crescentic, 3- to 4-angled, or winged cleft. Calcium oxalate in raphides occurring singly or in groups up to  $150\mu$  in length. Hypodermal and endodermal cells with lemon-yellow or reddish-orange porous walls and in the Mexican and Ecuadorian Sarsaparillas showing a distinctly irregular thickening, the cells being from  $80$  to  $500\mu$  in length; fragments of vessels with simple and bordered pores and scalariform, reticulate and spiral thickenings, associated with sclerenchyma fibers possessing thin, slightly lignified and porous walls.

## DISTINCTIONS BETWEEN OFFICIAL SARSAPARILLAS

Mexican	Honduras	Central American	Ecuadorian
<i>Occurrence:</i> Clusters of long roots attached to a crown with stout stem bases.	Clusters of long folded roots compactly bound together with roots of same plant to within a short distance of end of cylindrical bundle.	Folded roots loosely bound together with roots of same plant into somewhat flattened bundles.	Clusters of long roots usually attached to a crown having 1 or more purplish stem bases.
<i>Color (externally):</i> Grayish-brown to weak reddish-brown.	Reddish-brown to dark brown.	Weak reddish-brown to moderate yellowish-brown	Reddish-brown to purplish.
<i>External markings:</i> Broadly longitudinally furrowed, the furrows containing more or less of a blackish earth, few fibrous rootlets.	Longitudinally wrinkled or finely furrowed, the furrows usually free from earth; few fibrous rootlets.	Longitudinally wrinkled, rarely furrowed and bearing numerous coarse fibrous rootlets.	Longitudinally wrinkled or furrowed with occasional fibrous rootlets.
<i>Fracture:</i> Brittle in cortex, tough, fibrous in central cylinder portion.	Short in cortex, sometimes tough and fibrous in central cylinder.	Short, or tough and fibrous in central cylinder.	Short to fibrous in cortex; tough and fibrous in central cylinder.
<i>Internal characteristics:</i> The cortex is pale orange and mealy, or light yellowish brown and horny. The woody zone is porous and yellow. The pith is grayish and starchy.	The cortex is moderate brown to yellowish-orange and starchy. The woody zone is light yellow and porous. The pith is grayish-white and starchy.	The cortex is white or light brown and non-mealy. The woody zone is yellow and porous. The pith is lighter colored and starchy.	The cortex is brown to reddish-brown, mealy. The woody zone yellowish-brown and porous. The pith is white and starchy.
The outer and radial walls of the hypodermal cells are more thickened than the inner walls.	The cell walls of the hypodermis are almost uniformly thickened.	The walls of the hypodermal cells are almost uniformly thickened.	The outer and radial walls of the hypodermal cells in some specimens are more thickened than the inner walls; in others similar.
The inner and radial walls of the endodermal cells are more thickened than the outer walls.	The walls of the endodermal cells are nearly uniformly thickened.	The walls of the endodermal cells are nearly uniformly thickened.	The inner and radial walls of the endodermal cells in some specimens are more thickened than the outer walls, in others similar. The cells of the pericycle in roots examined were thicker walled than in the other 3 varieties.



**Constituents.**—The crystalline glycoside *sarsasaponin*; *parillin* and *smilacin*, which represent impure forms of sarsasaponin; sitosterol-*d*-glycoside, sitosterol, stigmasterol, starch, sarsapic acid, calcium oxalate, etc.

**Storage.**—Sarsaparilla should be preserved against insect attack.

**Uses.**—As an alterative in syphilis, rheumatism and other blood diseases usually in combination with potassium iodide and other ingredients. The contained saponins facilitate the absorption by the system of the active principles of other drugs combined with Sarsaparilla. A decoction of Sarsaparilla and tablets containing its saponins are used in the treatment of psoriasis.



FIG. 76.—*Aloe barbadensis*, the source of Curaçao and Barbados aloes.

**Average Dose** (unof.).—2 Gm. (30 grains).

**Preparations.**—Sarsaparilla Fluidextract, U.S.P., 2 cc. (30 minims); Compound Sarsaparilla Syrup, U.S.P. (from Fldext.), 15 cc. (4 fl. dr.).

**Adulterants and Substitutes.**—(1) Rhizomes of tropical species of *Pteris*; (2) roots of a *Philodendron*; (3) rhizomes and aerial stems of same plant.

#### ALOE U.S.P. (ALOE)

**Botanical Origin.**—(1) *Aloe Perryi* Baker, (2) *Aloe barbadensis* Miller (*Aloe vera* “Linné”), (3) *Aloe ferox* Miller and hybrids of this species with *Aloe africana* Miller and *Aloe spicata* Baker.

**Synonyms.**—*Aloes*. (1) Socotrine Aloe; (2) Curaçao Aloe, Bitter Aloe; (3) Cape Aloe.

**Part Used.**—The dried juice of the leaves.

**Purity Rubric.**—Aloe yields not less than 50 per cent. of water-soluble extractive. Not more than 12 per cent. of moisture; it yields not more than 4 per cent. of ash.

**Habitat.**—Africa.

**Plants.**—*Aloe Perryi* which yields Socotrine Aloe, is a perennial herb indigenous to Socotra. Its underground portion consists of an extensive fascicled root system. Its aerial portion comprises a trunk, rosette of thick succulent leaves and a raceme of flowers. As observed by Baker, the trunk attains a length of a foot and a diameter of  $1\frac{1}{2}$  to 2 inches. The succulent, lanceolate leaves are 12 to 20 in number and form a dense rosette at the summit of the trunk. They are pale green, becoming later frequently reddish, somewhat striate but not mottled. They attain a length of 15 in. and a breadth of 3 inches at the base, from which they taper gradually to an acuminate apex. They are channeled on their upper surface and exhibit small, deltoid, brown-tipped, marginal spines about a quarter of an inch apart. From the center of the leafy rosette there arises a raceme  $1\frac{1}{2}$  to 2 feet long. The peduncle portion of this is purplish, the pedicels red. The flowers which are borne upon the pedicels are tubular. They exhibit a cylindrical perianth of a brilliant red color with a green tip in their early stage, turning yellow upon maturity. The stamens are unequal. Both stamens and style are slightly exserted. The fruit is a membranous capsule.

*Aloe barbadensis*, the source of Curaçao Aloe, somewhat resembles in habit the preceding species. Its leaves are long and narrow, with repand and spiny margin, about 2 inches in thickness, 4 inches broad at the base and 12 to 20 inches long, when full grown. In color they are pea-green and when young are spotted with white. Its bright yellow tubular flowers are arranged along a slender loose spike. The stamens frequently project beyond the perianth tube.

*Aloe ferox* which yields Cape Aloe, is the loftiest of the whole genus. It sometimes attains a height of nearly 20 feet, the trunk below the rosette of leaves having been observed up to 3 feet long. The leaves are lanceolate, glaucous, becoming reddish and produce spines from every part, but stouter, longer, sharper and more curved ones are produced along the purplish margins and in a line along the middle of both the ventral and dorsal surfaces. The greenish-yellow to whitish flowers are tubular and borne upon a panicle inflorescence.

*Aloe africana* and *A. spicata* are arborescent species which are native to S. Africa.

**Histology of the Leaves.**—The leaves of all species of the genus *Aloe* are of the succulent, xerophytic, centric type. Either of the plants furnishing the official drug has leaves which, when examined microscopically, exhibit the following structural peculiarities:

A covering layer or epidermis containing scattered stomata, each surrounded in *Aloe ferox* by four neighboring cells. The outer walls of the epidermal cells are strongly cutinized. Beneath the epidermis is the mesophyll which is differentiated into an outer cortical and an inner central zone. The outer cortical zone comprises several layers of chlorenchyma cells containing chloroplasts; the inner (central) zone is composed of large, clear, thinner walled cells with abundant mucilage content.

On the border of the clear central and outer cortical zones are to be noted fibrovascular bundles arranged in the form of an ellipse. Each of these is accompanied by a number of long, tubular, thin-walled *pericyclic* cells containing a bitter juice which, when inspissated, constitutes the drug. I have observed cells in the bundles of a large number of sections, the contents of which took on a red coloration, when a 5 per cent. solution of potassium hydroxide was applied.



FIG. 77.—*Aloe Perryi*, the source of Socotrine and Zanzibar aloes.

This would seem to indicate that the bitter juice containing anthraquinone derivatives is found not only in the cells accompanying the bundles, as previously recorded, but in certain cells of the bundles themselves.\* Raphides of calcium oxalate are present in both cortical and central zones of the leaf.

**Production and Commerce.**—In the preparation of the drug, although the leaves of aloe-yielding plants are cut from nine, ten or twelve month old plants, they are not usually in the best of shape until the second or third year. When the soil is properly manured the plants have, in many instances, been found productive for ten or twelve years.

\* Youngken, H. W., "The Pharmacognosy of Aloes," *Pharm. Era*, p. 120, May, 1918.

In March or early April workers go out into the aloe fields. Each begins by grasping a bunch of blades and cutting them off at their bases. In the Dutch West Indies they are then quickly placed, cut end downward, in a V-shaped trough several feet long and a foot or more thick. This is then arranged on an incline, so that the juice, in trickling from the leaves, runs down the sides of the trough and through an aperture at its lower end into a receptacle placed beneath. When the receptacle is filled with juice, the latter is poured into a cask and evaporated spontaneously or reserved for later evaporation with the aid of heat. The latter process is accomplished by bringing the juice to a boil in copper vessels. As soon as the juice has thickened to a sufficient degree, it is poured into large gourd shells or boxes and allowed to harden. It is usually exported in spirit cases.

An inferior method sometimes employed is that of expressing the juice from the leaves, afterwards boiling it with water, evaporating and pouring into gourds. The resulting product is usually known as the "*common*" or "*ground*" *aloes*.

In Cape Colony the worker prepares a hollow in the ground and spreads therein a goat skin or piece of canvas. He then cuts off the aloe leaves and arranges them, cut surface inward, around the margin of the excavation until there are several radial series of leaves. The leaves are exhausted in 6 to 8 hours. The skin or canvas, upon being nearly filled with the juice from the leaves, is lifted from the ground, its contents emptied into a drum or paraffin tin and boiled until the proper consistency has been reached. It is then poured into oblong wooden moulds and allowed to harden. The resultant oblong masses are sometimes wrapped in oiled paper or tinfoil and packed in tins or yellow wood cases for shipment.

In Zanzibar the juice, after being collected and boiled to the proper point, is poured into skins which are sewed up subsequent to its introduction. The skins containing the drug are packed in cases for shipment.

The Socotrine Aloes is produced in East Africa, the island of Socotra and Arabia. It is obtained by a similar method used in Cape Colony, but the juice is permitted to evaporate spontaneously in a sheep or goat skin. It is brought in a wet condition by Arab traders to Red Sea Ports or Zanzibar, thence to Bombay where it is shipped in casks, kegs or skins to Europe, thence to the United States. Socotrine aloes is usually very wet, when imported, containing up to 20 per cent. or more of moisture. The Curaçao or West Indian Aloes, produced on the islands of Curaçao, Bonaire and Aruba of the Dutch West Indies, is shipped direct to the United States. Most of the aloes which was received by the United States within recent years was this commercial variety. Cape Aloes, produced in Cape Colony, is shipped from Mossel Bay and Port Elizabeth to Cape Town and thence exported to Europe and the United States. During 1947, 192,260 lbs. of aloes were imported into this country from Curaçao, Union of South Africa and Saudi Arabia.

**Description.**—Socotrine aloes is found in the form of reddish-black to brownish-black, opaque, smooth, and glistening masses, sometimes soft. It is readily

broken into pieces with a somewhat conchoidal fracture and sharp edges. Its odor when recent is disagreeable, but upon ageing it develops an odor resembling a mixture of saffron and myrrh. Its taste is nauseous and bitter.

Curaçao, or West Indian aloes, occurs in brownish-black opaque or semi-transparent (Capey Barbados Aloe) masses. Its fracture is irregular, exhibiting an uneven, waxy, sometimes resinous surface. Its odor is characteristic and its taste bitter and nauseous.

Cape aloes comes into the market in olive-black or dusky to dark brown masses frequently covered with a yellowish powder. Its fracture is sharp, exhibiting pieces with a smooth and vitreous broken surface. It has a distinct sour odor and a nauseous, bitter taste.

There occur on the market, in addition to the official commercial varieties described, certain sub-varieties of each of the official grades known as "*hepatic or livery varieties*." These are all opaque, darker in color, and obtained by allowing a partial fermentation of the juice to take place and then slowly evaporating it in the sun.

Zanzibar aloes is the hepatic (liver-colored) variety of Socotrine aloes. It is opaque, dark brown in color and has a smooth waxy fracture.

Barbados aloes is the hepatic variety of Curaçao aloes and occurs in deep chocolate brown, opaque, brittle masses.

Uganda or Crown aloes is the hepatic variety of Cape aloes. It comes into the market in the form of reddish-brown masses, which are more or less opaque.

**Powdered Drug.**—Dark yellow, yellowish brown to olive brown. When mounted in a fixed oil and examined microscopically, it appears as greenish-yellow to reddish-brown angular or irregular fragments.

*Fairbairn Test.*—When mounted in a mixture of 2 parts of glycerin and 1 part of 95 per cent alcohol, the fragments of different kinds of aloe can be distinguished by their crystals: Curaçao Aloe has short acicular crystals, 6 to 16 $\mu$ . Socotrine Aloe shows larger acicular crystals, 20 to 60 $\mu$ . Cape Aloe shows sheaf-like bundles of crystals. Zanzibar Aloe shows disc-shaped clusters of acicular crystals.

*Identity Tests.*—When treated with nitric acid on a white surface, it dissolves with effervescence forming a reddish-brown to brown solution (Socotrine Aloe), deep red solution (Curaçao Aloe), or a reddish-brown solution changing to purplish-brown and finally green (Cape Aloe).

Intimately mix in a flask or bottle 1 Gm. of finely powdered Aloe with 25 cc. of cold distilled water, shake the mixture occasionally during 2 hours, transfer it to a filter, and wash the filter and residue with sufficient cold distilled water to make the filtrate measure 100 cc.; the color of the filtrate, viewed in the bulb of a 100 cc. volumetric flask, is dark yellow with Socotrine Aloe, dark orange with Curaçao Aloe, and greenish-yellow with Cape Aloe.

**Constituents.**—A variable mixture of bitter pentosides which are hydrolyzed in the presence of alkalis into anthraquinone derivatives. *Barbaloin* ( $C_{21}H_{20}O_9$ ), a pale yellow anthraquinone glucoside (pentoside) (absent in Natal aloes). *aloe-emodin*, bitter resin; *isobarbaloin* is present in addition to the

foregoing in Curaçao and Barbados aloes; in Cape aloes there also is found an isomeric substance termed *β-barbaloin*. When barbaloin is boiled with alcohol acidified with hydrochloric acid, emodin ( $C_{15}H_{10}O_5$ ) is yielded. The resin of Curaçao aloes consists of barbaloresinotannol combined with cinnamic acid, that of Cape, Uganda, Natal and Socotrine aloes of capaloresinotannol combined with paracumaric acid. Natal aloes contains as its chief active principle the anthra-glucoside, *nataloin*.

**Uses.**—Purgative in colon constipation. Source of Aloin U.S.P. which has similar properties. It is contraindicated in hemorrhoids, menstruation and pregnancy.

**Average Dose.**—0.25 Gm. (4 grains).

**Preparations.**—Compound Benzoin Tincture, U.S.P., 2 cc. (30 minims); Aloe Tincture, N.F., 2 cc. (30 minims); Aloe Pills, N.F., 2 pills; Aloe and Mastic Pills, N.F. (Lady Webster Dinner Pills), 2 pills.

**Aloe Leaf.**—The fresh leaf and the pulp of the leaf of *Aloe barbadensis* Miller (*A. vera* of auths. not Linnæus) have been successfully used to increase the rate of healing of acute X-ray burns.

#### ALOIN U.S.P. (ALOINUM)

**Definition.**—Aloin consists of a mixture of active principles obtained from aloe. The drug varies in chemical composition and in physical and chemical properties according to the variety of aloe from which it is obtained.

**Description.**—It occurs as a lemon-yellow to dark yellow, microcrystalline powder or as minute crystals without odor or with a slight odor of aloe and intensely bitter taste. It is soluble in water, alcohol and acetone and slightly soluble in ether. Exposure to light and air darkens it.

**Identity Tests.**—Aloin is soluble in ammonia T.S. and in solutions of alkali hydroxides, forming red solutions having a green fluorescence.

**Ash.**—Not more than 0.5 per cent. **Water-insoluble substances.** Not more than 1.5 per cent.

**Use.**—Tonic laxative and purgative in colon constipation.

**Average Dose.**—15 mg. ( $\frac{1}{4}$  grain).

**Preparations.**—In N.F., Aloin, Belladonna, Cascara and Podophyllum Pills, 1 pill; Aloin, Strychnine and Belladonna Pills, 1 pill; Aloin, Strychnine, Belladonna and Cascara Pills, 1 pill; Aloin, Strychnine, Belladonna and Ipecac Pills, 1 pill.

#### CONVALLARIA N.F. (CONVALLARIA)

**Synonyms.**—Convallaria Root, *Lily-of-the-Valley Root*; *Fr.* Muguet; *Ger.* Maiglöcklein.

**Botanical Origin.**—*Convallaria majalis* Linné.

**Part Used.**—The dried rhizome and roots.

**Standard of Assay.**—Convallaria possesses a potency such that 0.1 Gm. of it is equivalent to not less than 3 U.S.P. XIII Digitalis Units.

**Purity Rubric.**—Not more than 5 per cent of foreign organic matter and yields not more than 6 per cent acid-soluble ash.

**Habitat.**—Mountainous regions of Europe, Asia and southeastern United States.

**Plant.**—A low, acaulescent, perennial herb widely cultivated for the beauty and fragrance of its flowers. Its subterranean portion consists of a branched,

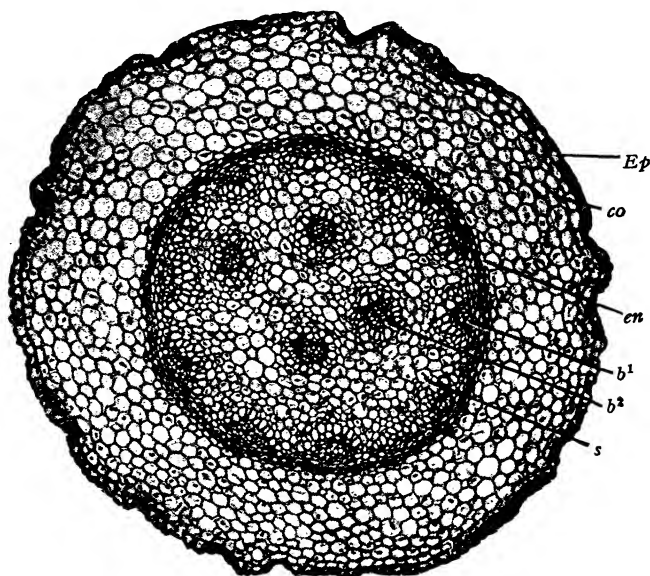


FIG. 78.—*Convallaria* Rhizome. Photomicrograph of a transverse section. *Ep*, epidermis; *co*, cortex; *en*, endodermis; *b*<sup>1</sup>, closed collateral bundle; *b*<sup>2</sup>, leptocentric bundle; *s*, stele.

creeping, horizontal rhizome bearing 3 to 9 fibrous rootlets from its nodes. Its aerial portion consists of 2 to 3 oblong, parallel veined leaves and later a slender scape bearing a one-sided raceme of small, white, bell-shaped, nodding flowers. The fruits are red berries.

**Production and Commerce.**—The rhizome and roots should be dug up during July and August, washed and dried. The commercial supplies of the drug used in this country come from Virginia, North Carolina and South Carolina.

**Description.**—Rhizome horizontal or oblique, elongated, usually branched, cylindrical, variable in length, from 1 to 3 mm. in diameter; externally moderate yellow to light brown; nodes with an occasional circular, hollow stem scar and with 3 to 9 thin, tortuous, brown, branching roots or root remnants or root-scars at each node; occasional terminal or lateral buds up to 8 mm. in thickness and with many scales; occasional groups of annulate leaf scars; fracture short or fibrous; internally whitish. Odor indistinct; taste sweetish, becoming bitter and acrid.

**Histology.**—Transverse sections of the rhizome present the following structures for examination:

1. *Epidermis* of a layer of epidermal cells whose outer walls are highly cutinized.

2. *Cortex* of about 20 rows of parenchyma cells, some of which contain more or less spherical starch grains, others raphides of calcium oxalate.

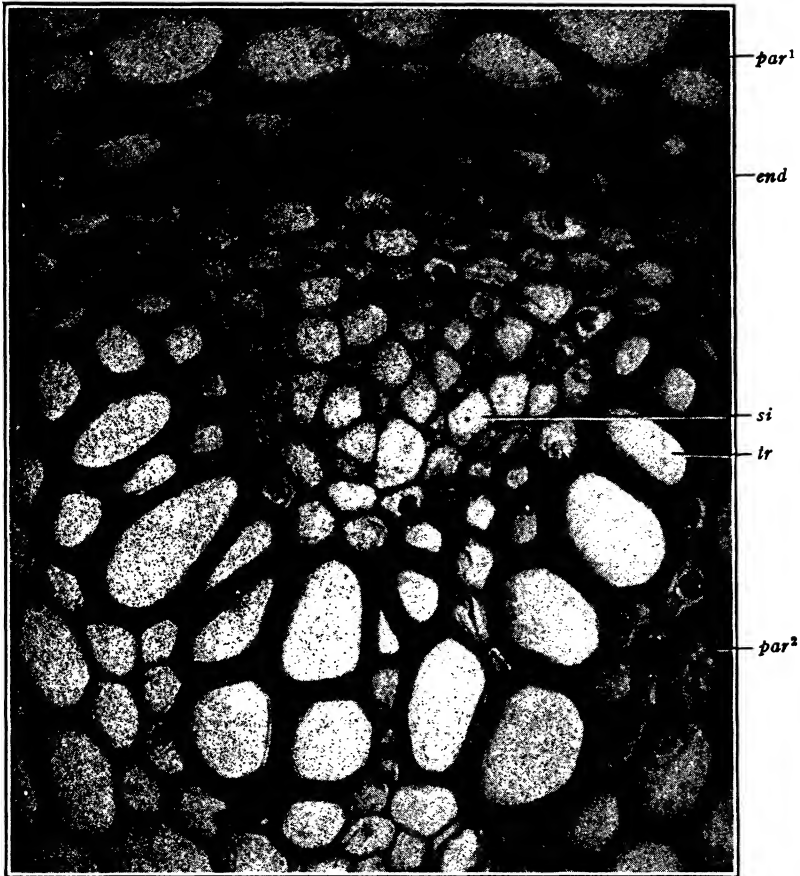


FIG. 79.—Highly magnified view of a closed collateral bundle of *Convallaria* rhizome and adjacent tissues. *si*, sieve tissue and *tr*, trachea in xylem of the bundle; *end*, endodermis; *par¹*, parenchyma of cortex; *par²*, parenchyma of stele.

3. *Endodermis* of usually 2 layers or occasionally 1 or 3 layers of endodermal cells, the radial and inner walls of which are strongly thickened and lignified.

4. *Stele*, a broad central region consisting of a matrix of starch- and crystal-bearing parenchyma through which course closed collateral and concentric (leptocentric) fibrovascular bundles.

The closed collateral bundles are arranged in an interrupted circle just within the endodermis. The woody portion of each is somewhat V-shaped. A few leptocentric bundles are scattered in the stele.

Transverse sections of the roots show a hairy *epidermis*; a *hypodermis* of a single layer of cells; a *cortex* of about 6 rows of cells, some containing starch,



raphides of calcium oxalate or oil; an *endodermis* of thin-walled cells whose radial and inner walls are slightly more thickened than the outer walls, and with casparyan spots on their radial walls; a layer of *pericambium*, a polyarch radial bundle and central *pith*.

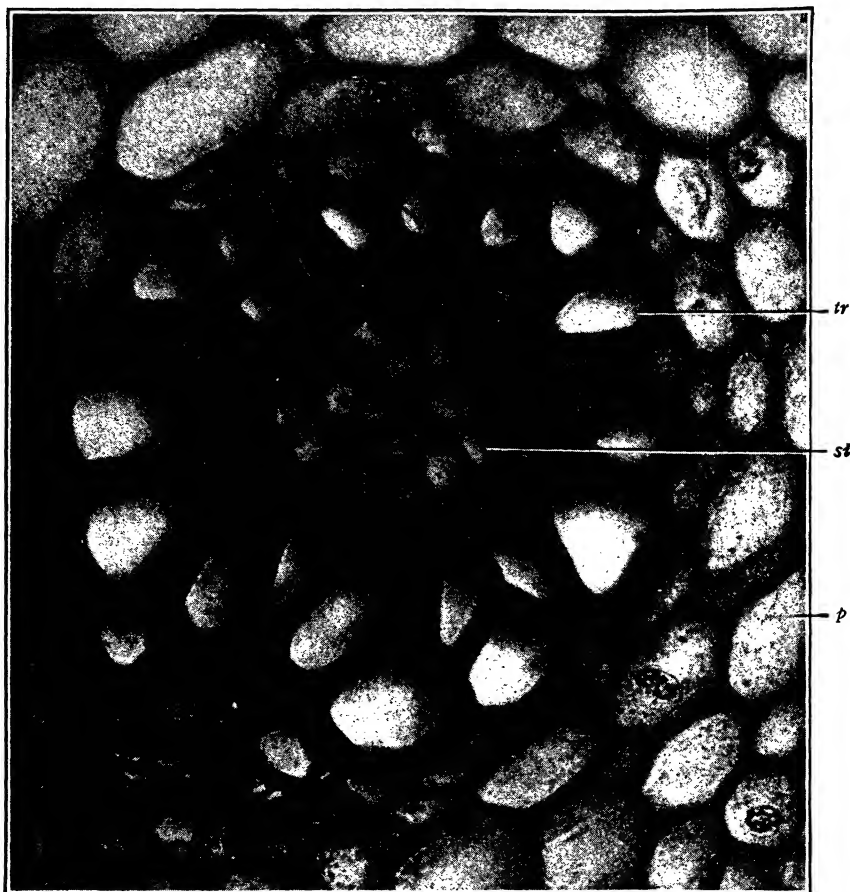


FIG. 80.—Highly magnified view of a concentric (leptocentric or phlocentric) bundle of *Convallaria* rhizome, imbedded in the central region of the stele. *tr*, trachea of xylem; *st*, sieve tube of phloem; *p*, parenchyma around bundle.

**Powdered Drug.**—Light brown to moderate yellowish-brown. It consists chiefly of cellular fragments and a few starch grains and raphides of calcium oxalate; cells of endodermis with straight or slightly oblique ends and considerably thickened, lignified, porous radial and inner walls; fragments of parenchyma associated with tracheæ with spiral, scalariform and reticulate thickenings, or with slightly lignified fiber tracheids; starch grains simple or 2- to 4-compound, the simple grains mostly nearly spherical, and from  $3\mu$  to  $12\mu$  in diameter; raphides of calcium oxalate few, usually from  $20\mu$  to  $60\mu$ , rarely up to  $150\mu$  in length; crystals of silica common in most specimens.

**Constituents.**—The cardiac tonic glycoside *convallatoxin* (Karrer, 1929) occurring in needle-like crystals only slightly soluble in water; the glycoside *convallamarin* ( $C_{23}H_{44}O_{12}$ ), soluble in water, to which is ascribed cardiac stimulant properties; another glycoside, *convallarin* (insoluble in water) which is emetic and cathartic; starch; calcium oxalate, etc.

**Use.**—Cardiac tonic in failure or threatened failure of compensation, usually in the form of fluidextract.

**Average Dose.**—30 mg. ( $\frac{1}{2}$  grain).

**Preparation.**—Fluidextract of *Convallaria* N.F. VII, 0.03 cc. ( $\frac{1}{2}$  minim).

#### ALETIS (ALETIS)

**Synonyms.**—True Unicorn-root, Stargrass, Starwort, Ague Root, Unicorn Root, Colic Root; *Ger.* Mehligle Aletris; *Fr.* Aletris farineux.

**Botanical Origin.**—*Aletris farinosa* Linné.

**Part Used.**—Dried rhizome and roots.

**Purity Rubric.**—Not more than 5 per cent. of foreign organic matter and yields not more than 10 per cent. of acid-insoluble ash.

**Habitat.**—Eastern United States in sandy and grassy woods.

**Plant.**—A perennial herb with a spreading rosette of thin lanceolate leaves from the center of which arises a slender scape bearing a spike-like raceme of small, white, tubular flowers. The fruit is an ovoid capsule inclosed by the perianth. The seeds are minute and ribbed.

**Production and Commerce.**—Aletris is gathered largely from plants growing wild in the southern states. It may be propagated either by division of the rhizome or from seed. If from seed, the seed should be gathered and sown soon after ripening in late summer and planted in a moist sandy soil in a seed bed. The seedlings should be transplanted to sandy soil in the spring and set about a foot apart in rows 2 ft. apart. Cultivation is essential. The rhizomes and roots are harvested in the autumn of the second or third year, the dirt being removed either by washing or shaking after which they are well dried. The commercial supplies of this drug are obtained from Virginia, North Carolina, and Tennessee.

**Description.**—The drug occurs in the entire and broken condition. Rhizome horizontal or slightly oblique, nearly cylindrical or laterally compressed above, 2 to 4 cm. in length and 12 mm. in diameter; externally weak brown to weak yellow; upper portion with circular, hollow stem scars, leaf bases or stem bases, the latter frequently up to 8 mm. in length, the sides and lower portion showing many tough, wiry, pale yellowish-gray to yellowish-brown, flexible roots, some of which have their cortex removed and exhibit a red, brown to purplish endodermis; fracture of rhizome short; internally pale yellow to moderate yellow exhibiting a thin cortex and broad central cylinder, the latter showing, under a hand lens, numerous scattered yellowish fibrovascular bundles; odor slight, acetous; taste starchy, sweetish and somewhat bitter.

**Microscopical Characteristics.**—Transverse sections of the **rhizome** show the following microscopical peculiarities, passing from periphery to center:

1. *Epidermis* of a layer of yellowish-brown epidermal cells bearing numerous glandular hairs with a short 1-celled stalk and a rounded head.

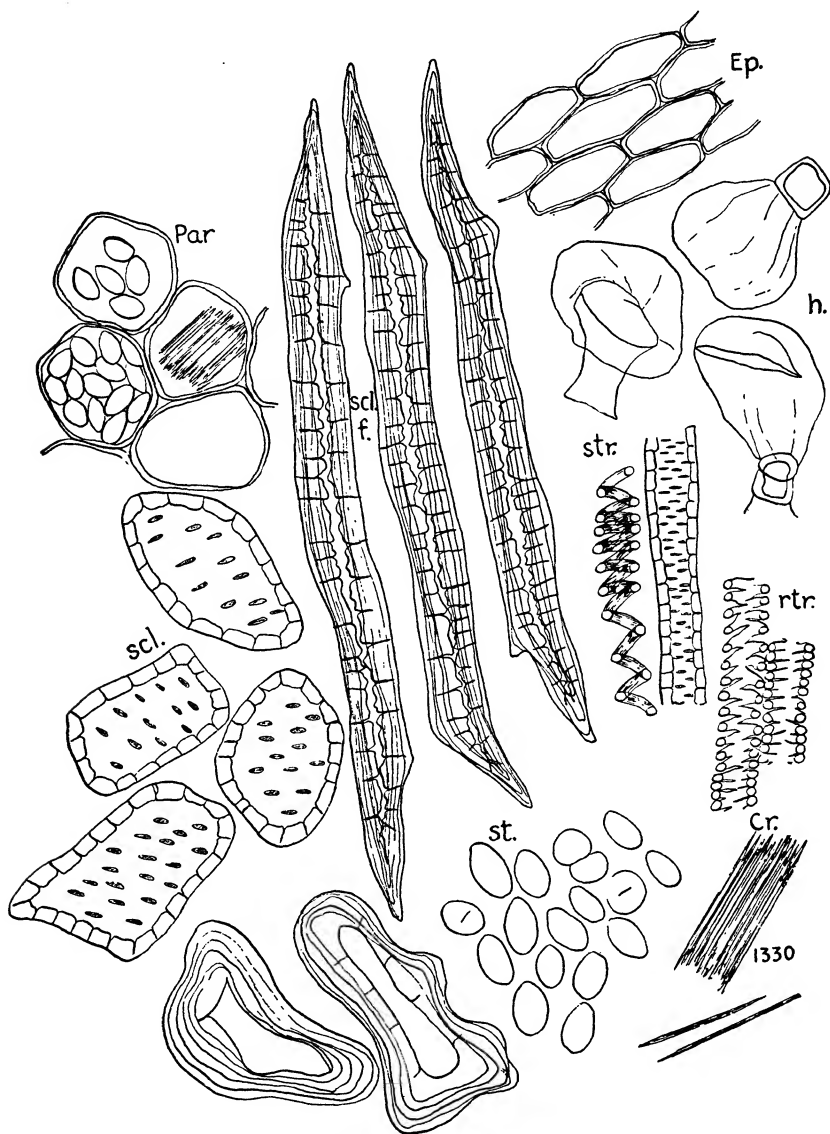


FIG. 81.—Powdered Aletris. *ep*, epidermis; *par*, starch- and crystal-bearing parenchyma; *scl. f.*, sclerenchyma fibers; *h.*, glandular hairs; *scl.*, stone cells; *st.*, starch grains; *cr.*, raphides of calcium oxalate; *str.*, spiral trachea; *rtr.*, reticulate tracheae. (Drawing by Izzo.)

2. *Hypodermis* containing one to several layers of stone cells, some with yellowish-orange colored contents.

3. *Cortex* of several layers of starch parenchyma, through which course leaf trace bundles of the closed collateral type.

4. *Endodermis*, an interrupted zone of several layers of yellow thick-walled cells, readily separating from the cortex.

5. *Central cylinder*, a broad zone of starch parenchyma containing scattered, branching, fibrovascular bundles, each with a small group of tracheæ and a sieve strand surrounded by several layers of thick-walled, lignified, sclerenchyma fibers, possessing large oblique pores. The tracheæ are reticulate and porous.

Many of the parenchyma cells of the cortex and central cylinder contain raphides of calcium oxalate, but most possess spherical or elliptical starch grains up to  $16\mu$  in diameter.

**Powdered Drug.**—Pale brown to light olive-brown; odor acetous; fragments of epidermis, some with glandular hairs; numerous orange-yellow to brown, thick-walled sclerenchyma fibers with pointed ends; fragments of porous and reticulate tracheæ and associated with lignified cells with thick walls and large, oblique pores; numerous fragments of parenchyma containing starch grains of a spherical or ellipsoidal shape, up to  $16\mu$  in diameter, numerous bundles of raphides or individual crystals of calcium oxalate up to  $50\mu$  in length.

**Constituents.**—A pharmacologically active amber colored *volatile oil* and *resinous material*, a saponin-like glycoside, beta glycosidase, an aglucone or sapogenin, starch, calcium oxalate, etc.

**Use.**—Uterine sedative, usually in the form of an elixir or fluidextract.

**Average Dose.**—2 Gm. (30 grains).

**Preparations.**—Fluidextractum Aletridis, 2 cc., Elixir Viburni Opuli Compositum, 4 cc. (N.F. VII.)

### HELONIAS (HELONIAS)

**Synonyms.**—False Unicorn-root, False Unicorn, Blazing Star.

**Botanical Origin.**—*Chamælririum luteum* (Linné) A. Gray.

**Part Used.**—The dried rhizome and roots.

**Purity Rubric.**—Not more than 5 per cent. of foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—In low grounds, Massachusetts to Florida, west to Nebraska and Arkansas.

**Plant.**—A perennial dioecious herb with a smooth stem 3–12 dm. high which arises from a tuberous rhizome and which is terminated by a spiked raceme of small white flowers. The leaves are lanceolate, the lower ones spatulate. The fruit is an ellipsoid, loculicidally 3-valved capsule up to 10 mm. long and containing numerous linear-oblong seeds.

**Commercial.**—Helonias is collected for the market chiefly in North Carolina, Virginia and Michigan.

**Description.**—Rhizome vertical or oblique, subcylindrical, from 0.5 to 3 cm. in length and about 1 cm. in diameter; externally weak brown to light yellowish-brown, annulate from scars of bud scales; upper portion with leaf bases enclosing a small bud; oblique rhizomes with a few stem scars up to 7 mm. in diameter; lower portion with numerous weak yellowish-orange to moderate

yellow, slightly curved, wiry roots, up to 8 cm. in length; fracture hard and horny internally light yellowish-brown to pale yellow, exhibiting a narrow cortex and a broad central cylinder with 3 to 4 irregular circles of small fibrovascular bundles; odor slight; taste bitter and slightly astringent.

**Histology.**—Transverse and longitudinal sections of the rhizome show a lignified cork zone, the cork cells with a brown amorphous content; a broad cortex, through which extend, outwardly, from the central cylinder, numerous lateral rootlets, emerging from the base of deep cylindrical pits which extend inwardly from the surface of the rhizome; *stele* of a matrix of parenchyma cells with many spheroidal or ellipsoidal starch grains from  $2-15\mu$  in diameter, numerous bundles of raphides of calcium oxalate up to  $40\mu$  in length; the fibrovascular bundles are leptocentric and arranged in 3 or 4 irregular circles, the tracheæ showing either annular, porous or reticulate markings. A cross section of the root exhibits an epidermis, a cortex of starch-parenchyma, an endodermis of radially elongated cells with lignified walls and a central radial bundle showing 5 to 7 mestome strands.

**Adulterants.**—The rhizome and roots of *Liatris* species (Fam. *Compositæ*) which possess a somewhat terebinthinate odor and bitter taste.

**Constituents.**—*Chamalirin* (a saponin) which is a yellowish-red amorphous substance soluble in water and alcohol (about 9.5 per cent.); starch, calcium oxalate, etc.

**Uses.**—Helonias has been used as a uterine tonic in amenorrhea and dysmenorrhea but is of questionable value. It is occasionally employed as a diuretic and anthelmintic.

**Average Dose.**—2 Gm. (30 grains).

### DIOSCOREACEÆ (YAM FAMILY)

Herbs or shrubs with twining herbaceous stems arising from large tuberous roots or knotted rootstocks. Leaves broad, frequently cordate and palmate-reticulate and varying from simple to compound. Flowers small, diœcious, regular, having a 6-cleft, calyx-like perianth, 6 stamens and a 3-celled ovary. Fruit usually a membranous, 3-angled or winged capsule containing winged seeds.

### DIOSCOREA (DIOSCOREA)

**Synonyms.**—Wild Yam Root, Rheumatism Root, Colic Root, China Root.

**Botanical Origin.**—*Dioscorea villosa* Linné.

**Part Used.**—The dried rhizome.

**Purity Rubric.**—Not more than 3.5 per cent. of attached roots or other foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—North America west to Kansas in thickets.

**Plant.**—A perennial herb with matted, woody rhizome bearing slender aerial stems which twine over bushes. The leaves are mostly alternate, cordate, acuminate, villous beneath, 9 to 11 ribbed, otherwise reticulate. The flowers are greenish-yellow and of two kinds, viz.: sterile and fertile. The sterile

flowers occur in drooping panicles, the fertile in drooping racemes. The fruit is a 3-winged capsule.

**Commercial.**—Wild Yam root is gathered in autumn and prepared for the market in Virginia, North Carolina, Indiana and Michigan.

**Description.**—Rhizome horizontal, knotted and woody, elongated, often compressed, bent and branched, frequently broken into pieces of varying length and 6 to 20 mm, thick, bearing scattered nodular lateral projections, tough filiform rootlets or thorn-like root remains in circular depressions below and



FIG. 82.—*Dioscorea villosa*.

depressed stem scars and occasionally slender twisted portions of aerial stems above; externally moderate brown to weak yellowish-orange, somewhat scaly; fracture very tough and short; fractured surface yellowish-white to pale yellowish-orange, with many small scattered yellowish wood bundles; odor indistinct; taste starchy, insipid and acrid.

**Powdered Drug.**—Weak yellow to light yellowish-brown; numerous fragments of thick-walled, lignified, parenchyma cells most of which contain starch, a few calcium oxalate crystals in raphides; numerous spheroidal and oval starch grains, up to  $35\mu$  in diameter; few isolated acicular crystals or raphides; fragments of fibrovascular bundles, the tracheæ and tracheids of which possess

minute bordered pores; fragments of reddish-orange to yellow epidermis; few lignified sclerenchyma fibers; a few endodermal fragments of rootlets with slightly lignified radial and inner walls; a few isolated lignified fibers.

**Constituents.**—An *acrid resin*, a *saponin-like principle*, starch, calcium oxalate, etc.



FIG. 83.—*Dioscorea*,  $\times \frac{1}{2}$ .

**Uses.**—*Dioscorea* is employed by the eclectics in the treatment of bilious colic and by others as a diuretic and expectorant.

**Average Dose.**—4 Gm. (60 grains).

**Preparations.**—Fluidextractum *Dioscoreæ*, 4 cc.; Tinctura *Viburni Opuli Composita*, 4 cc. N.F. VII.

#### IRIDACEÆ (IRIS FAMILY)

Perennial herbs with sword-shaped or linear, equitant, 2-ranked leaves, flattened at the sides and sheathing at the base. Flowers usually very showy, regular or irregular, hermaphrodite; perianth with 6 segments or lobes; stamens 3 with 2-celled anthers; ovary inferior, 3-celled with axile placentas or 1-celled with 3 parietal placentas; style slender, 3-lobed in upper part, the lobes entire or deeply notched, breaking up, in the genus *Iris*, at the insertion of the perianth, into 3 wide, petaloid style arms, each of which bifurcates at its extremity; ovules numerous, anatropous. Fruit a 3-celled, loculicidal, many-seeded capsule.

The roots arise from rhizomes, bulbs or corms which are mostly acrid. Stem vascular bundles concentric. Calcium oxalate crystals occur in the form of long prisms (styloids) within mucilage cells.

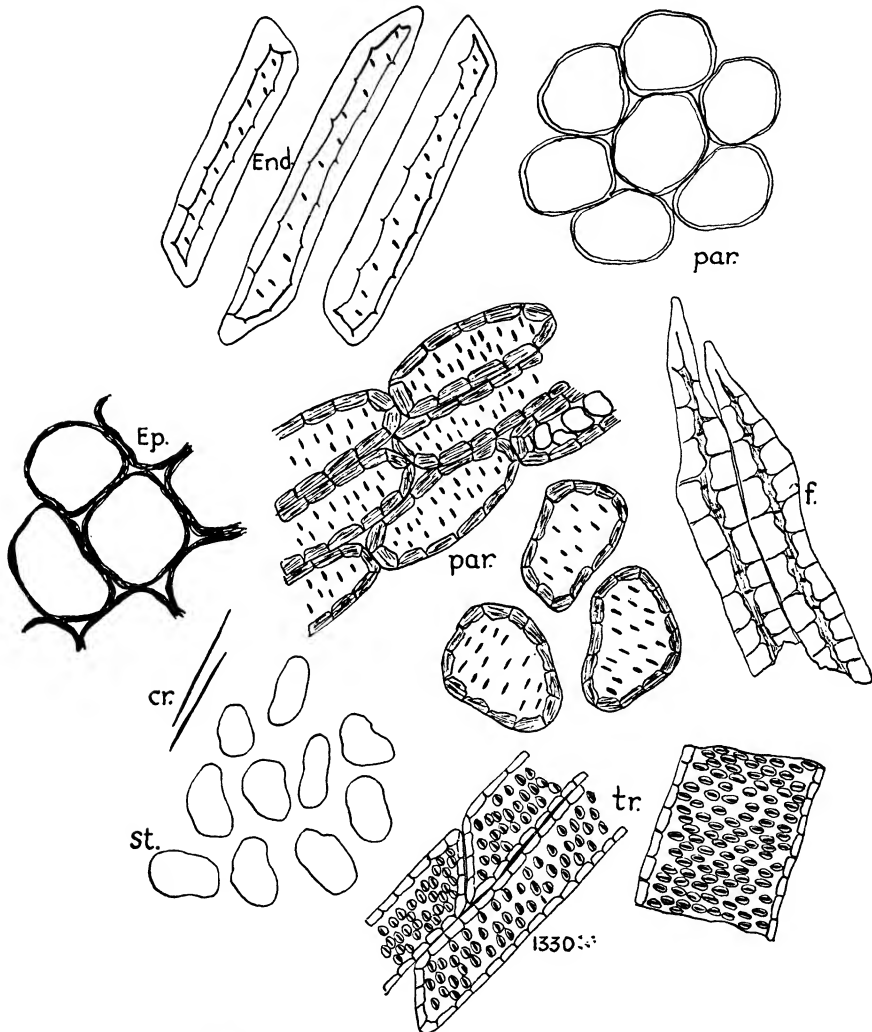


FIG. 84.—Powdered *Dioscorea*. *end*, endodermal cells; *par.* (upper right), cortical parenchyma; *ep*, epidermis; *par.* (in center), thick-walled, lignified parenchyma of stele; *f*, sclerenchyma fibers; *cr*, raphides of calcium oxalate; *tr*, tracheids and portion of trachea (to right) with bordered pores; *st*, starch grains. (Drawn by Izzo.)

#### CROCUS (CROCUS)

**Synonyms.**—Saffron, Spanish Saffron, True Saffron; *Fr. Gr.* Safran.

**Botanical Origin.**—*Crocus sativus* Linné.

**Part Used.**—The dried stigma.



**Purity Rubric.**—Not more than 10 per cent. of yellow styles of the plant, not more than 14 per cent of moisture, and not more than 2 per cent. of other foreign organic matter. It yields not more than 7.5 per cent. of total ash and not more than 1 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—Southern Europe and Asia.

**Plant.**—A perennial, low-growing, bulbous plant with an underground globular corm producing 6 to 9 sessile leaves surrounded in its lower part by 4 or 5 broad membranous scales. The flowers are borne on the terminal region of a scape. Each consists of a pale reddish-purple perianth showing a cylindrical tube about 4 in. long and 6 oblong oval segments, an androecium of 3 stamens and a gynœcium of 3 syncarpous carpels. The ovary is inferior, and 3-celled. The style is slender, elongated and pale yellow in the perianth tube and divided in its upper part into 3 drooping, deep red stigmas.

**Production and Commerce.**—The corms are planted usually in late spring about 6 inches apart and from 5 to 6 inches deep in soil of medium fertility, care being taken to thoroughly cultivate. The purplish-blue flowers appear in October and the leaves the following spring. The flowering period lasts from 2 to 3 weeks during which time the flowers are collected every morning, as they open. The deep red stigmas are then collected either by pulling them out or cutting them off with the finger nail, after which the flowers are discarded. The stigmas are dried by spreading them in a thin layer on a sieve suspended over a low fire, after which they are placed in linen bags and stored in a dry place. The yield per acre of saffron varies from 10 to 30 pounds. It is estimated that 50,000 flowers are required to produce a pound of the dried drug.

Most of the supplies of the drug come from Spain where the crocus plant is cultivated on a large scale. The plant is also cultivated for the drug in Italy, Germany, France, Greece, Austria, and Persia. It was formerly grown in various localities of the United States as a garden crop, notably in Lebanon and Lancaster counties, Pennsylvania.

The two most important commercial varieties are Valencia and Alicante Saffrons, the former being preferred because it consists almost entirely of stigmas. The foreign drug is imported in tin containers averaging 1 pound each chiefly from Alicante and Valencia, Spain. Some commercial supplies have been received from France, Italy and Denmark.

**Description.**—Stigmas 3, united or separate, attached to the top of the style; usually about 25 mm. in length, cornucopia-shaped, of a dark red color, the margin fimbriate or dentate; styles about 10 mm. in length, more or less cylindrical, solid, moderate yellowish-brown to weak yellowish-orange. Odor strong, characteristically aromatic; taste bitter, aromatic. Upon chewing the drug, the saliva is colored a bright orange-yellow. Saffron should not be exposed to light and should be preserved in amber-colored bottles or tin boxes.

When placed in sulfuric acid, saffron stigmas are immediately colored blue, gradually changing to violet, and finally to a deep wine color.

**Histology.**—The stigma consists chiefly of elongated, thin-walled parenchyma containing coloring matter and covered by a thin-walled epidermis.

The distal end of the stigma shows numerous bladdery, cylindric papillæ or trichomes up to  $150\mu$  in length, among which occur a few smooth, spherical pollen grains from  $40\mu$  to  $120\mu$  in diameter and occasionally pollen grains showing outgrowths in the form of pollen tubes.

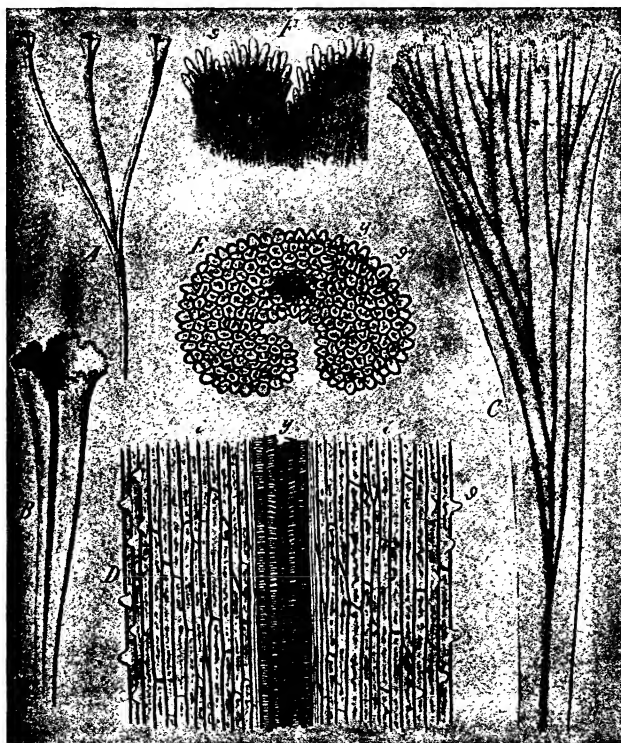


FIG. 85.—*Crocus sativus*. A. Upper end of style with its 3 stigmas (nat. size). B. A stigma,  $\times 4$ . C. The same, macerated, spread out and enlarged. D. Longitudinal section of the lower portion of stigma,  $\times 50$ . E. Transverse section through lower portion of stigma,  $\times 50$ . F. A portion of the epidermis of the upper end of stigma showing papillæ,  $\times 50$ . i, parenchyma; p, papillæ; y, fibrovascular bundle. (After Berg.)

**Powdered Drug.**—Orange-red. Fragments of stigma showing elongated, thin-walled cells containing red coloring matter and some showing more or less cylindrical papillæ up to  $150\mu$  long. Pollen grains, spheroidal, nearly smooth and up to  $120\mu$  in diameter, with reddish, granular contents, occasionally germinated and showing pollen tubes.

**Constituents.**—An impure mixture of red coloring substances of glycosidal character called *crocin* which imparts a yellow color to water in 1:100,000 dilution; a colorless glycoside termed *picrocrosin*, *volatile oil* (trace only), dextrose, etc. As first noted by Karrer, when crocin is treated with a cold, dilute solution of potassium hydroxide, two reddish, crystalline substances are formed. When the mother liquor was acidified, he obtained bluish-red crystals. These substances are known respectively as  $\beta$ -,  $\gamma$ - and  $\alpha$ -crocetin. The three crocetins as well as crocin are colored blue by concentrated  $\text{H}_2\text{SO}_4$ .

**Uses.**—Chiefly as a flavoring and coloring agent but also, by the laity, in the form of a tea as a stimulant, antispasmodic, diaphoretic (in measles) and emmenagogue.

**Adulterants and Substitutes.**—The crude drug has been adulterated with a variety of substances, the more common past adulterants and substitutes being the following:

(1) The ligulate florets of *Calendula officinalis* (Fam. *Compositæ*) that have first been colored with methyl orange or a red dye. *Calendula* may readily be distinguished by the ligula or strap-shaped portion of its corolla being 4- or 5-nerved and 3-toothed and by its epidermal cells containing yellowish droplets of an oil.

(2) The tubular florets of *Carthamus tinctorius* (Fam. *Compositæ*), commonly known as American Saffron or Safflower, have long been substituted for Saffron. These are of a deep orange-red color, 25 to 40 mm. long, and exhibit a thin, cylindrical corolla tube, terminating in a 5-cleft limb, each lobe being up to 6 mm. long. From the throat of the corolla tube projects the yellow anther column and through the center of this the stigma. The pollen grains are spheroidal and spinose.

(3) The tubular florets of *Onopordon acanthium* L. (Fam. *Compositæ*), the Cotton- or Scotch-Thistle, artificially dyed with a mixture of Ponceau 3R and tartrazine, and weighted with a mixture of ammonium nitrate or potassium nitrate, borax and glycerin, represent another adulterant.

(4) The stigmas of *Crocus vernus* which are shorter, of an orange color and more cleft at the apex.

The presence of any added *Compositæ* florets can be recognized microscopically by the typical spinose pollen grains aided by the characteristic ligulate or tubular floral structure of this group.

(5) Basal portions of the styles and dyed floral parts, such as stamens and petals, of *Crocus* have also been employed as adulterants of the crude drug.

(6) Substances to increase its weight, including glycerin, honey, sugars, mineral or vegetable oil, colored emery, chalk and gypsum. The presence of an added oil or glycerin may be detected by pressing the suspected material between filter paper, when translucent, oily spots will be noted.

(7) Exhausted saffron recolored with organic dyes. The presence of an added organic dye may be ascertained by digesting 0.1 Gm. of *Crocus* in 10 cc. of distilled water for 15 minutes with frequent shaking, filtering and adding 1 Gm. of charcoal to the filtrate, then shaking, allowing to stand for 10 minutes and filtering again. Since the color of Saffron is removed by the charcoal, a colored final filtrate would indicate the presence of an organic (coal tar) dye.

#### ORRIS N.F. (IRIS)

**Synonyms.**—*Orris Root*; *Ger. Veilchenwurzel*; *Fr. Iris de Florence*.

**Botanical Origin.**—*Iris florentina* L., *Iris germanica* L., or *Iris pallida* Lamarck.

**Part Used.**—The peeled and dried rhizome.

**Purity Rubric.**—Not more than 1 per cent. of foreign organic matter; it yields not more than 1 per cent. of acid-insoluble ash.

**Habitat.**—Mediterranean region.

**Plants.**—*Iris germanica*, commonly known as Fleur-de-Lis, is a perennial herb widely cultivated as an ornamental plant in the United States and growing wild in Virginia and West Virginia. Its subterranean portion consists of a horizontal branching, thick, annulated, rhizome system, bearing numerous equitant broad sword-shaped leaves, and later, long peduncled, 2- to 3-flowered spathes of flowers, the drooping sepals of which are dark violet purple with a

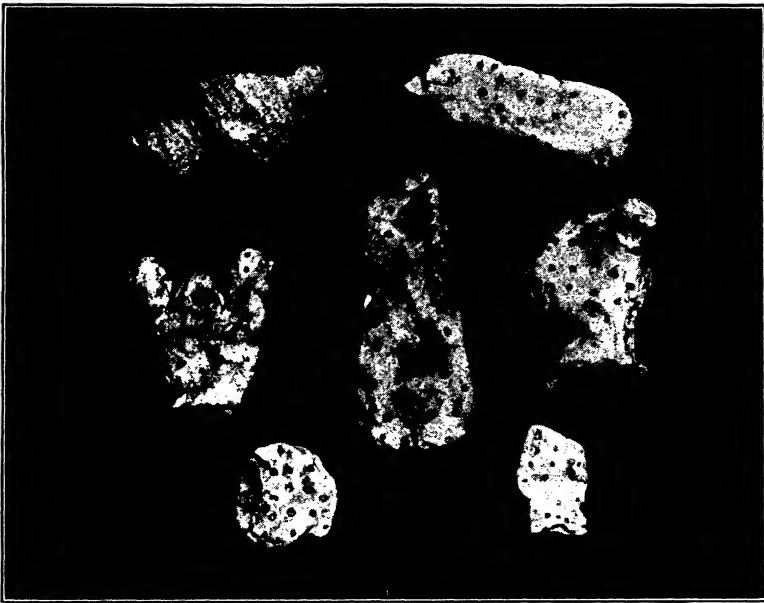


FIG. 86.—Orris,  $\times \frac{1}{2}$ . (Photograph by Stoneback.)

brilliant yellow beard, the petals lilac colored and of about the same size as the sepals. There are 3 distinct stamens, the anthers of which are overarched by the 3 style arms, the latter bearing their stigmas as thin lips beneath the apices of the arms. The fruit is a 3-angled capsule.

*Iris pallida* differs from the preceding species by bearing pale blue flowers. *Iris florentina* bears large white flowers and has the most fragrant root.

**Production and Commerce.**—The chief commercial varieties of Orris are the Florentine, Verona and Mogadore. The three species are cultivated chiefly in Italy for the drug. The rhizomes of 2 or 3 year old plants are dug up in late summer or early fall, deprived of their roots and outer cortex by peeling and dried in the sun and further dried in warm rooms. The fresh rhizomes are devoid of odor and possess an acrid taste, but during the drying process, they lose their acidity and develop their peculiar fragrance. *Iris florentina* and *I. pallida* yield the commercial variety known as Florentine Orris. This is the lighter and most plump and fragrant of the three varieties and demands

the highest price. Verona Orris is yielded by *Iris germanica* and *Iris pallida*. It is more yellow in color, less often branched and is generally not as carefully peeled as the Florentine variety. Mogadore Orris is yielded chiefly by *Iris germanica*. It is darker, more flattened and shrunken with less fragrance than the other two varieties and usually shows patches of a reddish cork and remains of buds on its exterior. The commercial supplies of the drug are imported from Italy, Portugal, French Morocco and Spain. During 1945, these countries shipped 336,423 lbs. of Orris to the United States.

**Cultivation.**—Orris is propagated by division of the rhizomes of old plants or from seed. The plants will thrive in a variety of soils but the rhizomes of those grown in gravelly soil appear to be most fragrant. Propagation from rhizome cuttings should be done in the spring or fall and the plants should be set a foot apart in rows at least 2 ft. apart for cultivation. They should be planted horizontally with only a light covering of soil. The cutting should represent a single section of the rhizome with a single fan of leaves and half the fan cut off to balance root disturbances. Sunlight and good soil drainage are essential for a successful crop. The rhizomes are harvested the third year, washed, deprived of their roots and corky epidermis and dried first in the open air and later in warm rooms. The dried drug must be preserved against insect attack during storage. The yield is from 5 to 6 tons per acre.

**Orris Fingers** represent trimmed pieces of Orris rhizome, usually perforated at one end, which are given to infants to assist dentition.

**Description.**—In entire or broken, usually jointed or branched pieces from 5 to 10 cm. in length and from 1.5 to 3 cm. in width, rounded or flattened, often with knotty enlargements; lower surface exhibiting numerous root scars, upper surface annulate from leaf scars; externally and internally yellowish-white to weak yellowish-orange; the unpeeled surface of Verona Orris orange-yellow; fracture strong, rough, and sometimes mealy, showing a narrow cortex, a distinct yellowish endodermis and a large stele with numerous scattered concentric fibrovascular bundles which are most numerous near the endodermis; odor fragrant, resembling violets; taste slightly sweet, aromatic, bitter and imparting an irritating sensation.

**Histology.**—Transverse sections exhibit the following characteristics:

1. *Cortex* of starch-bearing parenchyma cells possessing thickened, porous walls and intercellular spaces within which occur large solitary or twin prisms of calcium oxalate. These crystals also occur in crystal cells within the cortex that possess suberized walls.

2. *Endodermis* of rounded-polyhedral, endodermal cells, collenchyma-like, containing starch.

3. *Central Cylinder* (Stele). A large region of starch- and crystal-bearing parenchyma with scattered leptocentric vascular bundles throughout, the bundles being more numerous near the endodermis.

**Powdered Drug.**—Yellowish white to weak yellow; odor fragrant resembling violet flowers; numerous parenchyma cells filled with simple starch grains that are ovoid or oval, rounded at broader end and truncate at the other, some

curved or with irregular protuberances, many with a more or less horseshoe-shaped, X-shaped or pincers-shaped cleft in the large rounded end of the grain, 2 of the fissures extending to the small end of the grain, up to  $50\mu$  in length; fragments of cortex with irregularly polygonal cells having thickened, narrowly

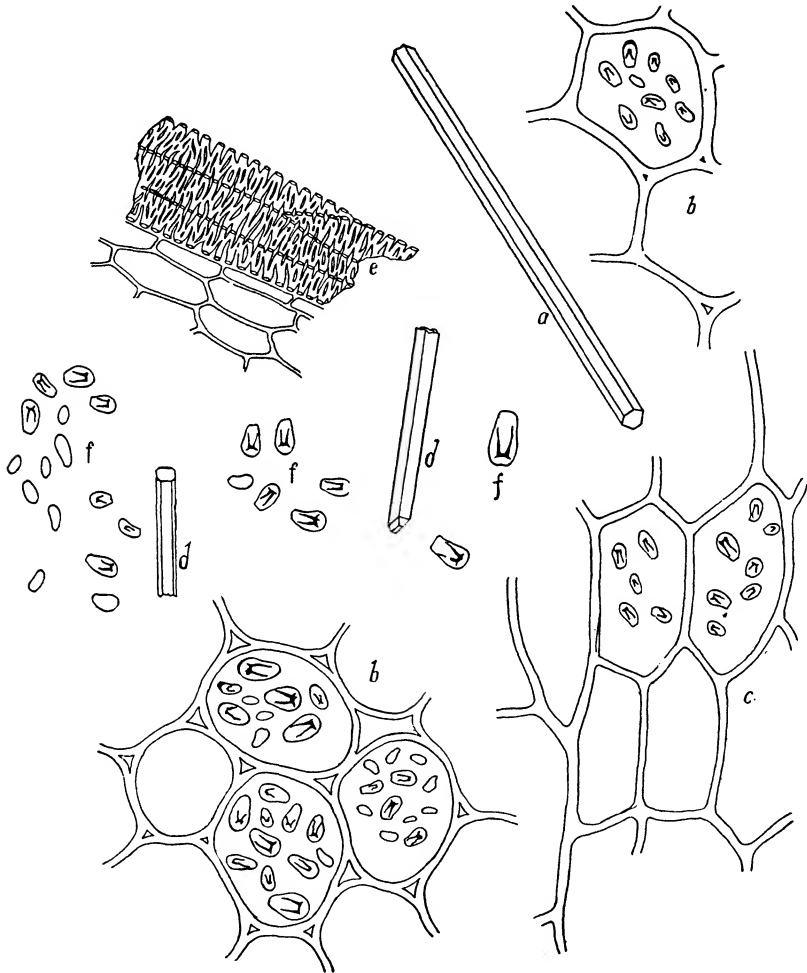


FIG. 87.—Powdered *Iris florentina*. (a) Large crystals of calcium oxalate; (b) parenchyma with starch; (c) parenchyma, longitudinal view; (d) broken prisms of calcium oxalate; (e) reticulate ducts; (f) starch grains showing characteristic horseshoe-shaped hilum. (Schneider.)

porous walls and good sized intercellular-air-spaces; spiral, annular, scalariform and reticulate tracheæ; elongated collenchymatous endodermal cells containing starch; large prisms of calcium oxalate up to  $500\mu$  in length and  $30\mu$  in width either intact or broken.

**Constituents.**—From 0.1 to 0.2 per cent. of an aromatic, yellowish-white, crystallizable *volatile oil* nearly solid at ordinary temperatures and known as

orris butter, containing *irone* and *myristic acid* as its chief constituents; a crystalline glycoside termed *iridin* ( $C_{24}H_{26}O_{13}$ ), mucilage, tannin, a bitter and acrid resin and 20 to 50 per cent. of starch. The fragrance of the root is due to irone ( $C_{13}H_{20}O$ ), a methyl ketone isomeric with ionone.

**Uses.**—In dentifrices, toilet powders and sachets, and as a constituent of Breast Tea. The volatile oil is used in perfumery.

### IRIS VERSICOLOR (BLUE FLAG)

**Synonyms.**—Blueflag, Larger Blue Flag; *Ger.* Amerikanische Schwertel *Fr.* Rhizome d'Iris varié.

**Botanical Origin.**—*Iris versicolor* Linné and *Iris virginica* Linné.

**Part Used.**—The dried rhizome.

**Purity Rubric.**—Not more than 5 per cent. of attached roots and leaf bases and not more than 2 per cent. of other foreign matter; it yields not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—In wet soil of eastern North America.

**Plant.**—*Iris versicolor* is a perennial herb native to the northeastern U.S. and Canada whose underground portion consists of a horizontal rhizome system. Its aerial portion consists of sword-shaped, glaucous leaves and short pedicelled, showy, violet-blue flowers which are variegated with green, yellow and white toward the center. The fruit is a 3-celled, loculicidally dehiscent, subcylindrical capsule with obtuse angles.

*Iris virginica* which grows in swamps from Virginia to Florida and Louisiana differs from the preceding species in possessing bright green leaves and lilac colored flowers variegated with yellow, brown and purple. Its rhizome is more deeply annulated than that of *I. versicolor*.

**Commercial Source.**—Most of the crude drug has been gathered from *I. virginica* L. in Florida. Smaller supplies are collected in North Carolina, New Jersey, Michigan, New York, and Indiana.

**Description.**—Rhizome simple or branched, up to 20 cm. in length and 3 cm. in thickness at the nodes, usually in longitudinally cut and broken pieces (*I. virginica*); outer surface weak red to moderate yellowish-brown occasionally purplish-brown, annulate, the upper surface exhibiting markings of leaf bases, the lower with numerous root scars and remnants of roots; fracture short and brittle; fractured surface dusky red to pale orange and showing a thick porous cortex, a distinct endodermis and a broad central stele with scattered light-colored fibrovascular bundles; odor slight to aromatic; taste acrid.

**Constituents.**—Acrid resins (about 25 per cent.), volatile oil, tannin, sugar, starch, etc. "*Iridin*" is an oleoresin obtained by precipitating the tincture of this drug with water. "*Irisin*" is similarly prepared but the oleoresin is stiffened by the addition of some powdered root.

**Uses.**—Cathartic and diuretic.

**Average Dose.**—2 Gm. (30 grains).

## ZINGIBERACEÆ (GINGER FAMILY)

Tropical plants, perennial herbs, with fleshy rhizomes and thickened roots which usually contain secretion sacs with volatile oil content, the latter frequently colored yellow by curcumin. The leaves vary from lanceolate to elliptic and are pinnately veined or parallel veined. They are either all radical or, in a few instances, alternate on a simple stem, occurring there in 2 rows. The petiole generally forms a split sheath, sometimes ligulate. The leaf sheaths are folded tightly around each other, so as to often give the appearance of a stem. The flowers are hermaphrodite, irregular, trimerous and either solitary or arranged in racemes, spikes or panicles. Sepals 3, short, often green; petals 3, elongate, often fused below; stamens 3 to 4 abortive, petaloid, one often absent, a sixth alone fertile and stamen-like. The petaloid stamens constitute the most attractive parts of the flower. Pistil tricarpeillary with inferior 3- to 2-celled ovary with axile placentas, or 1-celled with parietal or basal placentas and terminal style. Fruit a capsule, generally loculicidally dehiscent and crowned with the remains of the perianth (*Cardamomum*, etc.) or fleshy and indehiscent. Seeds numerous, angular or nearly rounded, frequently possessing an aril and containing perispermic and endospermic albumen. The fibrovascular bundles of the stems and leaves are either collateral or concentric. The starch grains are characteristically beaked at the hilum end of the grains.

## GINGER U.S.P. (ZINGIBER)

**Synonyms.**—Ginger Rhizome; *Ger.* Ingwer; *Fr.* Gingembre.

**Botanical Origin.**—*Zingiber officinale* Roscoe.

**Part Used.**—The dried rhizome, known in commerce as Jamaica Ginger, African Ginger and Cochin Ginger. The outer cortical layers are often either partially or completely removed.

**Standards.**—Not less than 4.5 per cent. of ether-soluble extractive. Not less than 12 per cent. of cold-water extractive.

**Habitat.**—S. Asia. Naturalized in Jamaica, Africa, West Indies, Mexico and Florida.

**Plant.**—A perennial herb with a subterranean, digitately branched rhizome that sends up stems that are covered by leaf sheaths. Leaves alternate, smooth, pale green and lanceolate. Flower stems shorter than leaf stems and bearing a few flowers, each surrounded by a thin bract and situated in axils of large, greenish-yellow obtuse bracts, which are closely arranged at end of flower stem forming collectively an ovate-oblong spike. Each flower shows a superior tubular calyx, split part way down one side; an orange-yellow corolla composed of a tube divided above into 3 linear-oblong, blunt lobes; 6 staminodes in 2 rows, the outer row of 3 being inserted at mouth of corolla, the posterior 2, small, horn-like, the anterior petaloid, purple and spotted and divided into 3 rounded lobes; and an inferior, 3-celled ovary with tufted stigma.

**Production and Commerce.**—Ginger is extensively cultivated in tropical and sub-tropical localities of both the Eastern and Western Hemispheres.



Chief amongst those producing varieties of commercial ginger are the West Indies, Africa, India and Japan. It is propagated from rhizome cuttings each containing a bud, which are planted several inches deep and about a foot apart in holes or trenches from March to May, depending upon the latitude. The plants mature in about 9 or 10 months. The rhizomes are dug up upon the death of the aerial portions of the plants and washed. They are then prepared in different ways for the market. In some instances they are peeled and then washed in clean water, often containing lime juice, after which they are spread out on mats or barbecues and dried in the sun for 5 or 6 days. They are not allowed to get damp during the period of drying lest they become moldy. After drying the rhizomes are bleached by washing and dried again for 2 days. In Jamaica this is the method employed in preparing the official "Peeled Jamaica Ginger." In others, they are peeled on the flattened sides, treated with boiling water and subsequently dried, as is the case with the African and Indian varieties ("Coated or Unscraped Ginger"). Again, they may be peeled or scraped and then coated with carbonate or sulfate of lime to protect against attacks of insect larvæ. Limed gingers should be regarded with suspicion for "liming" has been resorted to by unscrupulous dealers to cover up defects in the "wormy" drug. Moreover, the rhizomes may be first peeled and then bleached by the use of sulfurous acid or chloride of lime ("Bleached Ginger").

The peel and off-fall in Jamaica Ginger preparation is occasionally imported for oil distillation.

The principal commercial varieties are the following: Natural Jamaica, Bleached Jamaica, African, Calcutta, Calicut, Cochin and Japanese. Most of the Ginger imported into this country within recent years came from Jamaica, China, India, British W. Africa, Cuba, French Oceania, Mexico and Honduras, in bags. During 1947, 2,375,286 lbs. of unground Ginger entered the U. S. A. The Jamaica, Cochin, and African varieties only are recognized by the U.S.P. XIII.

**Description of Commercial Varieties. Jamaica Ginger.**—Rhizomes devoid of outer suberized layers, in horizontal, laterally compressed, irregularly branched pieces up to 16 cm. in length and up to 20 mm. in thickness; externally weak orange to weak yellowish-orange, longitudinally striate, ends of branches with depressed stem scars; fracture short and uneven, mealy, fibrous and resinous; internally yellowish-brown to yellowish-orange; cortex thin, endodermis a thin yellow layer enclosing a large stele with numerous groups of fibrovascular bundles and yellowish oil cells; odor agreeably aromatic; taste aromatic and pungent.

*Ratoon Ginger* is an inferior variety of Jamaica Ginger consisting of small, imperfectly peeled segments of the rhizome of a grayish brown color.

**African Ginger.**—Rhizomes with cork partly removed on the flattened sides, the surface areas without cork smooth and of a light brown color, the surfaces with cork reticulately or longitudinally wrinkled and grayish-brown; fracture short or short fibrous; internally light yellow to brown with yellow oil cells and reddish-brown resin cells; odor strongly aromatic; taste aromatic and strongly pungent.

**Cochin Ginger.**—Rhizomes with most or all of the corky layer removed on the flattened sides; externally light brown to yellowish gray; fracture shorter, less fibrous and more starchy than the other official varieties; internally weak yellow to medium yellow with numerous yellowish oil cells and, in old drug, brownish red to black resin cells; odor aromatic; taste strongly aromatic and pungent.

**Calcutta Ginger (Race Ginger).**—Rhizomes somewhat resembling African Ginger, the branches being usually larger, and with a considerable portion of

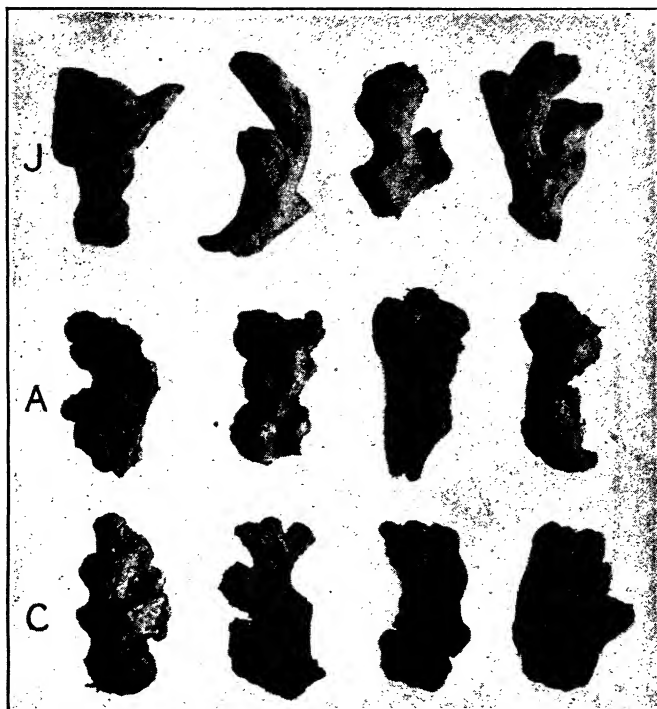


FIG. 88.—Varieties of Ginger,  $\times \frac{1}{4}$ . J, Jamaica. A, African. C, Cochin.

shrivelled pieces, externally grayish-brown or grayish-blue; fracture short and brittle, mealy, or horny; internally light yellow or light brownish-yellow with many yellowish oil cells and yellowish-brown resin cells; odor aromatic; taste starchy, strongly aromatic and pungent.

**Calicut Ginger (Lemon Ginger).**—Rhizomes resembling African Ginger, but more of the periderm is usually removed; externally dark yellow, orange or reddish-brown; fracture brittle and uneven, mealy; internally light yellow or brownish-yellow with large stele and numerous yellow oil and resin cells; odor aromatic; taste strongly aromatic and pungent.

**Japanese Ginger** (from *Zingiber Mioga* Roscoe).—Rhizomes usually with a thin coating of lime; externally nearly smooth and of a whitish color; fracture short, brittle and very mealy; internally yellowish-white to light brown with numerous brownish-red resin cells; odor aromatic; taste strongly aromatic and pungent.

**Microscopical Characteristics.**—Transverse sections of Jamaica Ginger, cleared by warming in chloral hydrate solution, show the following structure, passing from periphery toward the center: (see Fig. 89).

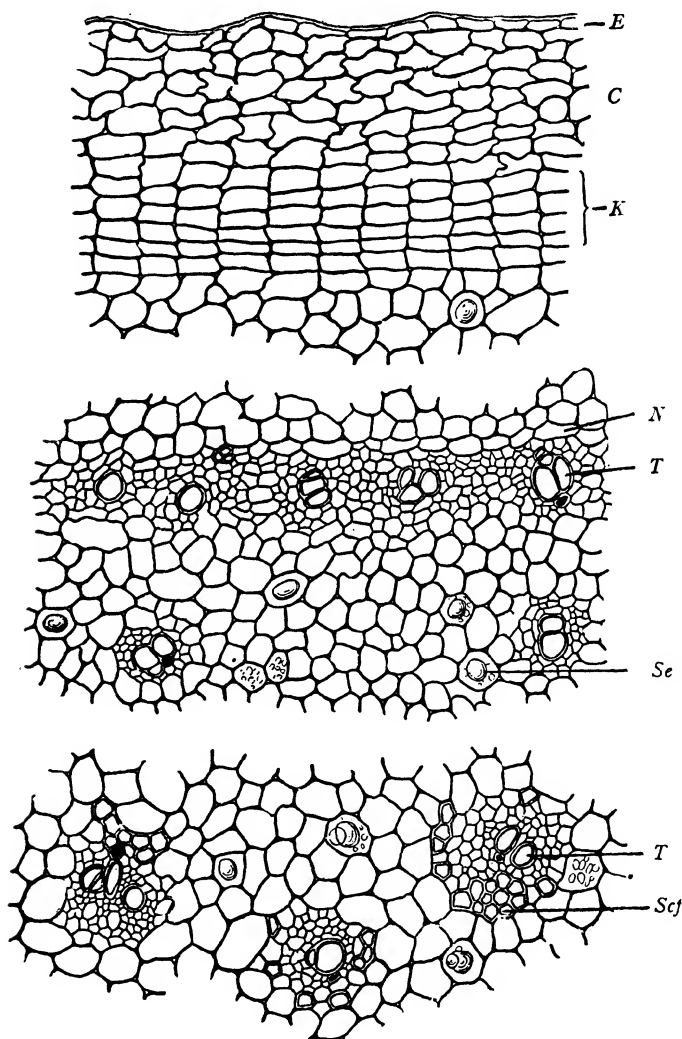


FIG. 89.—Transverse section through a representative portion of an unpeeled Ginger rhizome. Epidermis (*E*); cortex (*C*); cork (*K*); endodermis (*N*); tracheae of fibrovascular bundle (*T*); secretion sac containing oil and resin (*Se*); sclerenchyma fibers (*Scf*). (*Tschirch and Oesterle*.)

1. *Cortex* of several layers of ordinary parenchyma cells with intercellular-air-spaces and containing gelatinized starch (due to warming in chloral). Scattered among the typical cells of this region will be noted secretion sacs which contain a greenish-yellow to orange oil or oleoresin (if rhizome is recent)

or brown to reddish-brown resin, insoluble in alcohol (if rhizome is old). Leaf-trace bundles cut obliquely or transversely will also be seen coursing through this region.

2. *Endodermis*, a pale brownish layer of cells whose walls are somewhat collapsed, the radial walls of which appear highly refractive upon warming the section in strong potash solution. Upon washing out the potash solution with water and adding a drop or two of concentrated sulfuric acid, these radial walls do not dissolve and so are suberized.

3. *Stele*, a broad central zone of ordinary parenchyma cells, air spaces and secretion sacs, similar in character to the cortex. In this region, just inside of the endodermis, will be observed a circle of crowded, closed collateral fibro-vascular bundles, some possessing a single trachea, others groups of two or more tracheæ. Scattered irregularly throughout the remainder of the stele are larger closed collateral bundles of more or less rounded form with sclerenchyma fibers partially surrounding them.

Longitudinal-radial sections mounted in water exhibit elongated parenchyma cells filled with starch grains. Some of the starch grains can be observed outside the margin of the section and will be found to vary in shape and size. Ovoid, elongated-ovoid, and irregularly rounded forms can be made out, some of which are beaked at one end. The hilum is near the beak. They vary in size from 5 to  $40\mu$ , usually, rarely attaining  $50\mu$  to  $60\mu$  in the long axis.

Two kinds of secretion sacs will be observed: one being rounded and containing a yellowish oil or oleoresin or reddish-brown resin, another adjacent to tracheæ and narrowly elongated with yellowish-brown contents.

The tracheæ vary in character, most being reticulate, others spiral, still others scalariform, and are frequently non-lignified. The sclerenchyma fibers are elongated, more or less wavy-walled and possess oblique pits. The ends of the fibers are either tapered, rounded or square.

Longitudinal sections mounted in sulfuric acid dissolve with exception of the walls of the secretion sacs and radial walls of endodermal cells which, accordingly, must be suberized. Mounts made in phloroglucin and hydrochloric acid show no red coloration of the walls of many of the sclerenchyma fibers; some, however, take a pinkish tint, showing slight lignification.

**Powdered Ginger.**—Weak yellowish-orange (Jamaica Ginger), light yellowish-brown to moderate yellow (African and Cochin Ginger). Starch grains numerous, of ovoid, spherical and elliptical to irregularly rounded or ovoid shape will be seen, many with one end beaked, 5 to  $50\mu$ , occasionally up to  $60\mu$ , in the long axis and showing an eccentric hilum near smaller end and striations. Adhering to many of the starch grains are granular particles of proteid matter or fill starch. Mounts of material, cleared by warming in 5 per cent. potassium hydrate solution or 1 per cent. hydrochloric acid and washing with water, show long, thin-walled, frequently non-lignified fibers, distinctly undulate on one side and with oblique pores, reticulate, spiral and scalariform tracheæ, which are frequently non-lignified in their walls, as well as numerous greenish-yellow to reddish-brown secretion cells, the latter with suberized walls and with oil or

resin content. Long fiber-like cells with suberized walls and brown to dark brownish-red, resin-like contents are occasionally present. Fragments of thin-walled parenchyma cells are also evident. Yellowish or brownish, thin-walled, cork cells are only occasional in Jamaica Ginger and scraped Cochin Ginger but numerous in African and unscraped Cochin Gingers.

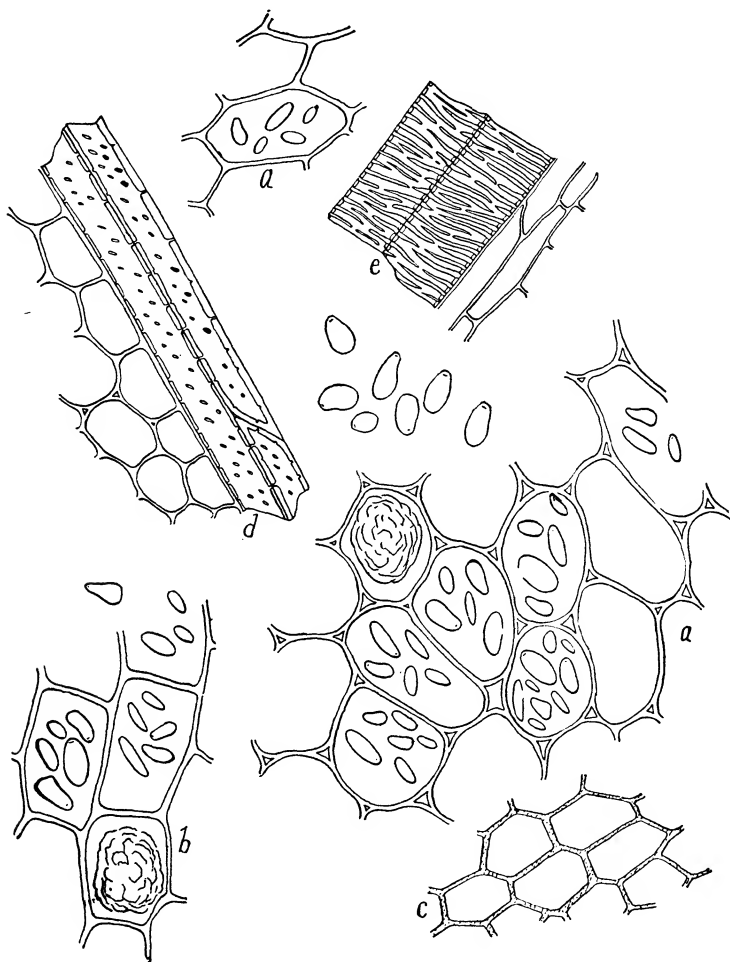


FIG. 90.—Powdered Zingiber. (a) Parenchyma with starch, transverse view; (b) parenchyma, longitudinal view, showing one secretion sac containing a mass of resin; (c) cork, vertical view; (d) tracheids; (e) reticulate tracheæ. (Schneider.)

Japanese Ginger shows numerous 2- to 3-compound starch grains and partially compound grains of 2 to 6-components in addition to single starch grains. The single starch grains vary from spheroidal and up to  $25\mu$  in diameter to ellipsoidal and ovoid, the latter types up to  $45\mu$  in length. The hilum is less eccentric than in the starch grains of *Zingiber officinale*.

**Constituents.**—*Volatile oil*, 1 to 3 per cent., consisting for the most part of the terpenes phellandrene and dextro-camphene and the sesquiterpene zingi-

berene; *zingerone* (4-hydroxy-5-methoxyl-phenylethyl-methyl-ketone), an extremely pungent crystalline substance chemically related to capsaicin, which gives to the drug its hot pungent taste; resins and starch.

**Standard of Purity.**—The United States Department of Agriculture has ruled that products labeled Ginger must conform to the following standard: Ginger is the washed and dried, or decorticated and dried, rhizome of *Zingiber officinale* Roscoe. It contains not less than 42 per cent. of starch, not more than 8 per cent. of crude fiber, not more than 1 per cent. of lime (CaO), nor less than 12 per cent. of cold water extract, nor more than 7 per cent. of total ash, not more than 2 per cent. of ash insoluble in hydrochloric acid, nor less than 2 per cent. of ash soluble in cold water.

Jamaica ginger is ginger grown in Jamaica. It contains not less than 15 per cent. of cold water extract, and conforms in other respects to the standards for ginger.

Limed ginger (bleached ginger) is whole ginger coated with carbonate of calcium. It contains not more than 4 per cent. of carbonate of calcium, nor more than 10 per cent. of total ash, and conforms in other respects to the standards for ginger (S.R.A. F.D., U. S. Dept. Agr., No. 2, Rev. 5, 1936).

**Uses.**—In medicine as a carminative, stimulant, and flavoring agent; as a condiment or spice in many food products and in beverages. Cracked ginger is a constituent of whole mixed pickling spice.

**Average Dose.**—0.6 Gm. (10 grains).

**Preparations.**—Ginger Fluidextract U.S.P., 0.6 cc. (10 minims); Ginger Oleoresin N.F., 30 mg. ( $\frac{1}{2}$  gr.); Ginger Syrup N.F. (from Fldext.), 10 cc. (2 $\frac{1}{2}$  fl. dr.); Aromatic Powder N.F., 1 Gm. (15 gr.); Compound Rhubarb Powder N.F. (Gregory's Powder), 2 Gm. (30 grains).

**Adulterants.**—Powdered Ginger has been frequently adulterated with exhausted or "spent" ginger. This may be detected by the diminution in the ash soluble in cold water (which should not be lower than 2 per cent.) as well as by the decreased yield of cold water and alcoholic extract. Wheat Middlings, Wheat Flour, Ground Flaxseed, and Corn Meal have also been found admixed with the ground or powdered drug. Ground turmeric has sometimes been added to the adulterated article to bring up its color to that of the genuine and ground capsicum or grains of paradise added for pungency. These may be detected by microscopical examination.

#### GALANGA (GALANGA)

**Synonyms.**—Galangal, Chinese Ginger, China Root, East Indian Root; Lesser Galangal, Rhizoma Galangæ; *Ger.* Galgant; *Fr.* Racine de Galanga.

**Botanical Origin.**—*Alpinia officinarum* Hance.

**Part Used.**—The dried rhizome.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter and not more than 3 per cent. of acid-insoluble ash (N.F. V).

**Habitat.**—China.

**Plant.**—A perennial, reed-like herb bearing stems about 1 m. in height which are covered by the leaf sheaths of narrow lanceolate leaves. The inflorescence is a short raceme of white flowers that are shaded and veined with dull red.

**Production and Commerce.**—The plant is cultivated for the drug on the island of Hainan to the south of China and on the adjacent mainland coast around Pak-hoi. The rhizome is dug in late summer or early autumn, washed, trimmed, cut into segments and carefully dried. The commercial supplies of the drug are shipped from Hongkong, Shanghai and Hang-Chow, China in bales made of split cane and bound with cane.



FIG. 91.—Galanga,  $\times \frac{1}{4}$ . (Photograph by Stoneback.)

**Description.**—The drug occurs in the form of branched or simple segments of the rhizome up to 11 cm. in length and up to 2 cm. in diameter, marked with wavy annulations of the leaf bases which possess a lighter color than the remainder of the surface; externally reddish or cinnamon-brown; internally orange-brown; fracture fibrous and uneven; odor agreeably aromatic; taste aromatic, spicy and pungent.

**Constituents.**—A greenish yellow *volatile oil* containing *cineol*, *eugenol*, *sesquiterpenes*, *isomerides of cadinene*, etc.; resin containing *galangol*; the tasteless yellow crystalline bodies called *kämpferide* and *galangin*; starch, etc.

**Uses.**—Aromatic stimulant, carminative and condiment. Galangal Oil is used as a flavoring agent in French liqueurs, in bitters of the Angostura type and in some tobacco.

**Average Dose.**—1 Gm. (15 grains).

## CURCUMA (TURMERIC)

**Synonyms.**—Turmeric Rhizome, Yellow Root; *Ger.* Kurkuma; *Fr.* Safran des Indes.

**Botanical Origin.**—*Curcuma longa* Linné.

**Part Used.**—The prepared rhizome.

**Habitat.**—Southern Asia and East Indies.

**Plant.**—A perennial herb whose underground portion consists of an erect, ovate or pyriform, fleshy rhizome which gives rise to less fleshy elongated branches (secondary rhizomes), roots and leaves.

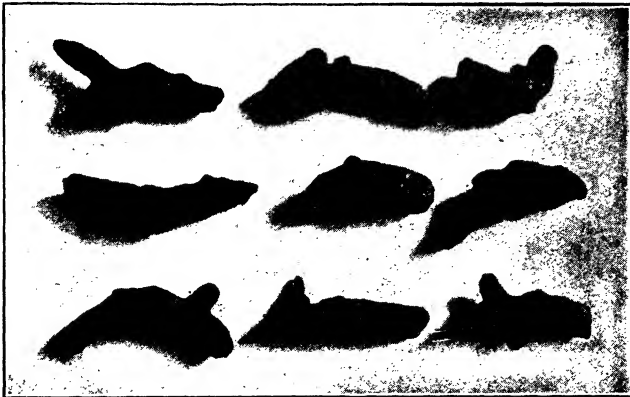


FIG. 92.—Long Turmeric. Rhizomes of *Curcuma longa* (Fam. *Zingiberaceæ*) showing branches and leaf scars, the latter represented by the annulations which appear on the surfaces of several of the rhizomes in the figure.  $\times \frac{3}{8}$ .

**Production and Commerce.**—Turmeric is grown extensively in China, India, Cochin China and Java from rhizome cuttings. The rhizomes are dug up at the close of the season's growth, washed and then prepared for the market either by scalding or boiling. During this process the starch becomes more or less altered, the contents of many of the cells becoming swollen to form pasty masses that are colored yellow by the curcumin also present in the cells. The rhizomes are then quickly dried in the sun. There are two important forms on the market, viz.: *Round turmeric* representing the ovate or pear-shaped, fleshy main rhizomes and *Long turmeric*, the more slender, elongated, somewhat cylindrical and branched secondary rhizomes. Of the two main commercial varieties (Alleppy and Madras), the Alleppy is the more esteemed since it is claimed to hold its color better when exposed to light in glass containers. The commercial supplies of this drug have been imported from British India, the United Kingdom, China, Japan, Haiti and Jamaica.

**Description.**—Ovate, oblong or pyriform (round turmeric) or cylindrical and often short-branched (long turmeric); the round about half as broad as long, the long form from 2 to 5 cm. long and 1 to 1.8 cm. thick; externally yellowish to yellowish-brown, with root scars and annulations, the latter from the scars of leaf bases; fracture horny; internally orange-yellow to orange,



waxy, showing a cortex separated from a central cylinder (about twice as broad as cortex) by a distinct endodermis; in both cortex and central cylinder scattered bundles are seen; odor aromatic; taste warmly aromatic and bitter.

**Powdered Drug.**—Deep yellow. Its chief diagnostic elements are the altered, pasty masses of starch colored yellow by the curcumin and, in some

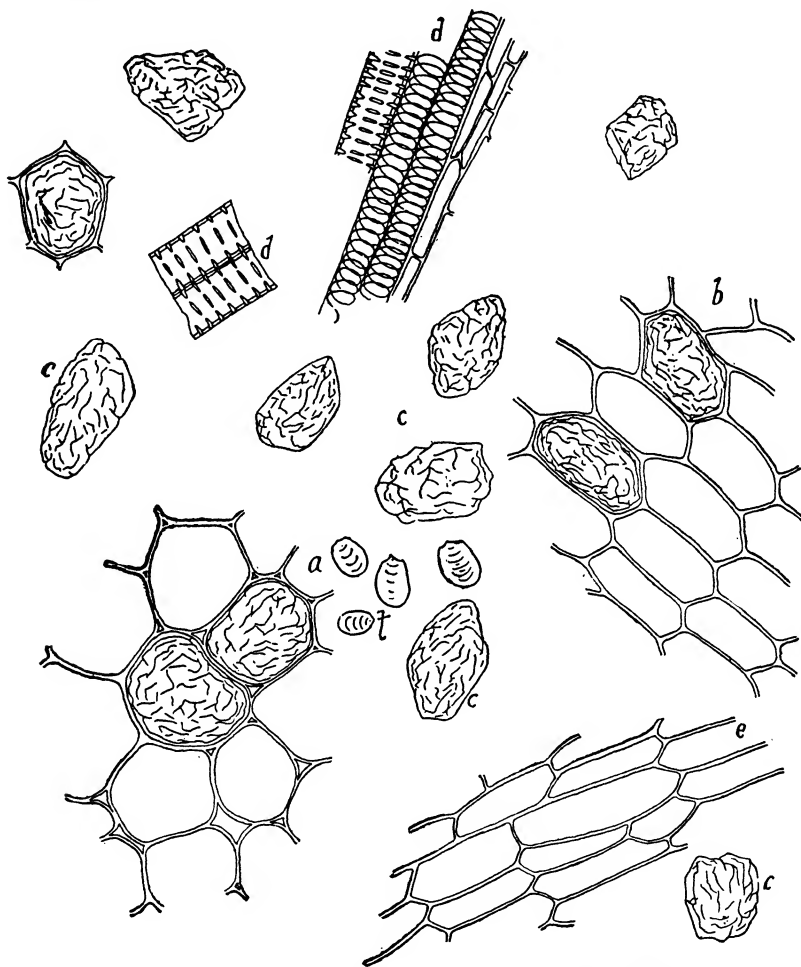


FIG. 93.—Powdered turmeric (*curcuma*). (a) Parenchyma with altered starch; (b) parenchyma, longitudinal view; (c) masses of altered starch; (d) ducts; (e) parenchyma; (f) normal starch granules. (*Schneider*.)

lots, the unaltered starch grains which are simple, ovate or irregularly ovate with a beak at the hilum end and up to  $60\mu$  in length. See Fig. 93.

**Constituents.**—About 5 per cent. of *volatile oil*; *curcumin*, starch, resin, etc. Curcumin ( $C_{19}H_{21}O_2(OH)_2(OCH_3)_2$ ) is a yellow crystalline substance which dissolves in alcohol forming a deep yellow solution; boric acid colors it red, which upon the addition of alkalis becomes greenish-blue; an alcoholic solution of sulfuric acid imparts a deep crimson color to all tissues containing it.

**Uses.**—Turmeric is a stimulant, coloring agent and condiment. It is an ingredient of many curry powders and prepared mustards and pickles. Turmeric paper is prepared from the tincture and used as a test for boric acid, borates, and alkalies.

#### CARDAMOM SEED U.S.P. (CARDAMOMI SEMEN)

**Synonyms.**—Cardamom Seed; *Ger.* Kardamomen; *Fr.* Cardamomes.

**History.**—Cardamom is mentioned in the ancient Sanskrit writings of Susruta. It is listed as an Indian spice in the customs liable to duty in Alexandria, A.D. 176–180 and first described as a product of the Malabar coast by the Portuguese navigator Barbosa in 1563. The species first used as a spice was probably the *Amomum Cardamomum* of Siam and Java, which is thought to represent the *Αμωμον* of Dioscorides and *Amomi uva* of Pliny. During the past century *Elettaria Cardamomum* plants of the Malabar and Mysore types have been introduced from India into Ceylon where they have become established under cultivation and now yield most of the official drug.

**Botanical Origin.**—*Elettaria Cardamomum* Maton.

**Part Used.**—Dried ripe seed, recently removed from the capsules.

**Purity Rubric.**—Not more than 4 per cent. of acid-insoluble ash.

**Habitat.**—Indo-China, in mountainous districts. Cultivated in Ceylon and near the Malabar coast of India, and recently in Guatemala.

**Plant.**—A perennial zingiberaceous herb attaining a height of 6 to 12 feet. Its leaves are lanceolate and borne on long sheathing stems. The numerous flowers are borne on horizontal racemes that arise from the rhizome and run horizontally along the ground. The fruit is an ovoid, loculicidally dehiscent capsule, the seeds of which are covered by an aril.

**Production and Commerce.**—Cardamom is cultivated in moist shady mountain forests of southern India, Ceylon and Guatemala. In Mysore the plants are grown in the betel-nut plantations between the palms. The plants are propagated either by division of the rhizomes or by seed planted in nursery beds. The seedlings, when approximately a foot in height are transplanted into partly cleared level jungle in the shade of trees and in holes 7 feet apart. They begin to bear fruits in their third year. The fruits (capsules) of the pure species and its varieties *α-minor*, the smaller form, and *β-major*, the larger form, are gathered before maturity when starting to turn from green to yellow. Either the entire raceme may be cut (in India) or only nearly ripe fruits may be cut off with scissors from the rachis (in Ceylon) by coolies. They are dried either on the cut inflorescence by sun, or, the fruits are stripped off, carried to the houses and dried on mats for several days or by means of a gentle fire heat. They are subsequently cured on trays by sun or the shade of houses, clipped by machines, to remove the calyx tube at the apex and pedicel at the base, graded by sieves, sorted as to color, bleached by exposure to dew and sunlight or sulfurous acid and steam, and finally dried in the sun. The drug is exported both in the fruit (capsules) and seed form in chests. The fruit wall or pericarp

contains only about 0.2 per cent. of volatile oil whereas the seeds contain up to 7 per cent. of this active ingredient. Seeds which have been removed from their capsules become inferior in time to those that have been retained. The seeds should be stored in a cool place and against attack by insects. The greater bulk of the drug imported into this country has been either shipped direct from Colombo, Ceylon, and from Bombay, and Delhi, India, or through London. Malabar and Mysore Cardamoms come chiefly from Colombo; Mangalore from Mangalore through Bombay or Delhi, Alleppy from Travancore through Bom-

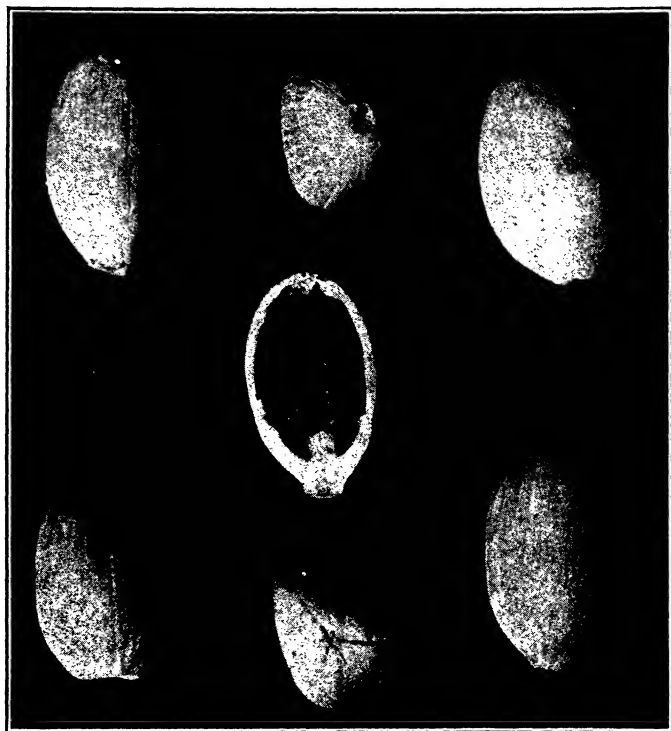


FIG. 94.—Mysore Cardamom Fruits,  $\times 1\frac{1}{2}$ . In center, a capsule with portion of pericarp removed, showing seed masses covered with membranous arillus.

bay and London. Increasing supplies have recently been coming forward from San Cristobal, Colban and Livingstone, Guatemala.

There are several varieties of Cardamom capsules which may be classified under two captions, based upon size and commercial source respectively. Thus, according to size, there are the "Shorts" (12 mm. long, 6 mm. broad) that are broad and plump, "Short-longs" (18–25 mm. long, 6 mm. broad) that are finer ribbed and lighter than the shorts, and "Longs" (25–30 mm. long, 4 mm. broad). According to the growing district or shipping port there are the following named varieties: 1. Malabar or Ceylon-Malabar. 2. Mangalore. 3. Mysore or Ceylon-Mysore. 4. Alleppy or Aleppi. 5. Guatemala.

**Malabar** or Ceylon-Malabar Cardamom, when bleached, is recognised as of excellent grade. It consists of "shorts" and "short-longs," of ellipsoidal or ovoid shape, light buff in color, with 15-18 aromatic and pungent seeds. It is chiefly obtained from plants cultivated in Ceylon.

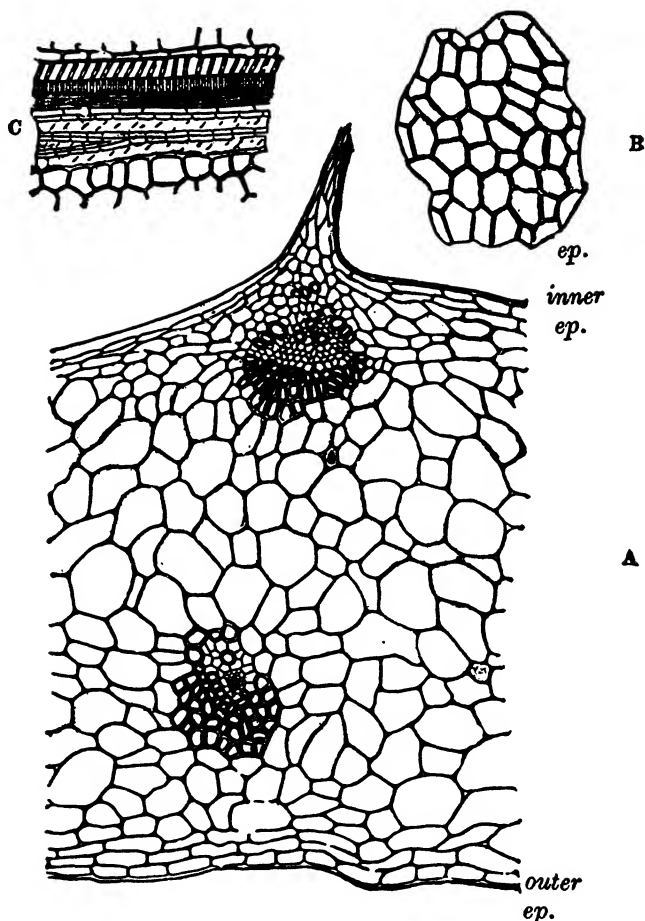


FIG. 95.—Cardamom Fruit. Histology of the pericarp. A, cross section with projecting wall of ripened ovary, showing two fibrovascular bundles with supporting sclerenchyma fibers and surrounding mesocarp of parenchyma; B, epicarp in surface view; C, longitudinal section of bundle. (After Tschirch and Oesterle.)

✓ **Mangalore Cardamom** closely resembles the Malabar variety but the fruits are frequently larger, nearly spheroidal and have a rough coat. They are grown in the Province of Coorg and shipped from the port of Mangalore on the Malabar coast of India or via Bombay.

✓ **Mysore or Ceylon-Mysore Cardamom**, the best grade, consists mostly of "shorts" that are ovoid-oblong, more rounded than the Malabar variety, yellow to cream colored with nearly smooth surface and containing 9-12 seeds

which are not as pungent as those of Malabar Cardamom. It is now largely obtained from plants cultivated in Ceylon.

Alleppy Cardamom is elongate-ovate, 3-cornered, green, greenish-brown, yellow or brown. It comes from plants grown in Travancore State and shipped from the ports of Alleppy and Cochín. The "Alleppy Greens" are claimed to be the best cardamoms for use in distilling the volatile oil.

Another cardamom which shows promise of future use in America is the Round Chinese Cardamom claimed by Guibourt to be yielded by *Amomum globosum* Loureiro. This is yielded by an evergreen plant which grows wild and is under cultivation in the Kwang-Tung province of China. Its capsular fruit is round or globular, about 15 mm. in diameter and thickness, pale yellow, longitudinally ridged, pointed at both ends and covered with long, non-glandular hairs, with a thin wall and containing about 24 seeds. The seeds are brownish-yellow, pyramidal and exhibit a deep furrow on one side, 4 mm. in length and 3 mm. in width, and aromatic in odor and taste. They yield about 5 per cent. of a yellow volatile oil having a strong odor of cardamom and a camphoraceous and cooling taste.

The following Cardamoms, obtained from various other species and a variety have an inferior flavor:

Round or Cluster Cardamom, from *Amomum Cardamomum* L. of Siam and Java is globular to globular-ovate; up to 15 mm. in diameter with seeds having a camphoraceous taste.

Bengal Cardamom, from *Amomum aromaticum* Roxburgh, has 9 wings near the summit of the capsule. Its seeds are about 3 mm. long and possess an aromatic, camphoraceous taste.

Winged Java Cardamom, from *A. maximum* Roxburgh, has 9-12 wings that extend from base to summit.

Wild Ceylon Cardamom, yielded by *Elettaria Cardamomum* var. *β-major* Smith (var. *major* Thwaites) consists of the fruits of wild plants. These are shrivelled, coarsely striated, up to 40 mm. long, dark gray-brown, display a beak about 15 mm. in length and possess a slightly bitter taste. They were formerly used in distilling the oil of cardamom.

The U.S. Dept. of Agriculture requires that Cardamom fruits be obtained from *Elettaria Cardamomum* and that Cardamom seed contain not more than 8 per cent. of total ash, nor more than 3 per cent. of ash insoluble in hydrochloric acid.

**Physical Characteristics of Seeds.**—These are mostly agglutinated in small groups of 2 to 7 by the adhering loosely attached membranous aril, the individual seeds, oblong-ovoid, or irregularly 3- to 4-sided, from 3 to 4 mm. in length, 3 mm. or less in diameter, convex on the dorsal surface, prominently longitudinally grooved on the ventral side; externally of pale orange to dark brown color, transversely furrowed and tuberculated; internally whitish, exhibiting a small reniform cavity containing an embryo; odor aromatic; taste aromatic and pungent.

**Microscopical Characteristics.**—Transverse sections of the seed show the following tissues passing from periphery toward the center: Fig. 96.

1. *Arillus*, a loosely attached membrane of tangentially-elongated, thin-walled cells.

2. *Spermoderm*, consisting of (a) an outer layer of epidermal cells with thickened angles, (b) a layer of pigment cells with red to orange contents, (c) a layer of large clear cells containing the volatile oil of cardamom, (d) a layer or

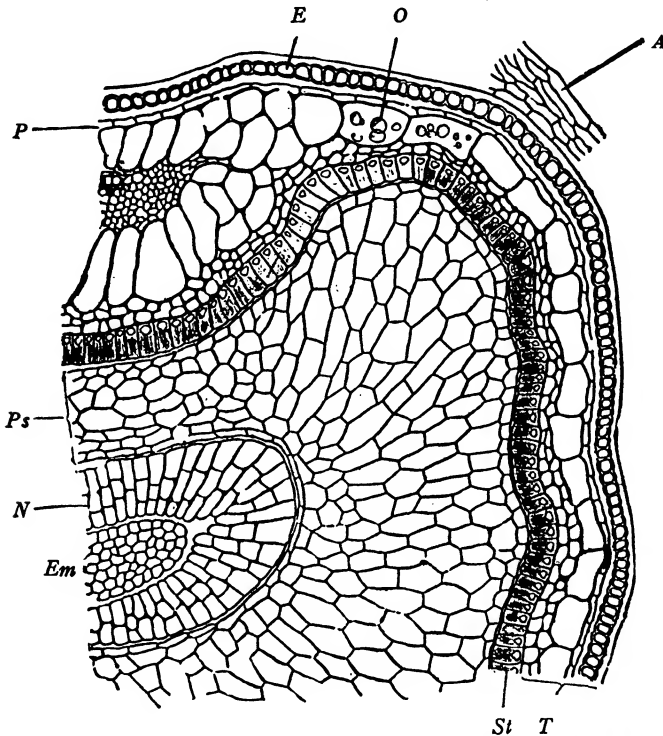


FIG. 96.—Transverse section of Cardamom Seed. Arillus (A); epidermis (E); parenchyma (P); oil cells containing oil globules (O); testa from outer integument (T); stone cells (St); with greatly thickened inner and radial walls, many containing a nodule of silica; perisperm (Ps); endosperm (N); embryo (Em). (After Tschirch and Oesterle.)

two of thin-walled, tangentially elongated parenchyma cells and (e) a layer of radially elongated brown, greatly lignified stone cells with inner walls heavily thickened and a minute triangular lumen near the outer wall which contains a nodule of silica.

3. *Perisperm*, a broad zone consisting of an outer layer of small aleurone cells loaded with aleurone grains and many layers of polygonal cells loaded with masses of minute spheroidal and polygonal starch, each grain of which is  $1\mu$  to  $4\mu$  in diameter. In about the center of many of these masses one or more crystals of calcium oxalate occur.

4. *Endosperm*, a small orange to yellow zone surrounding the central embryo. Both of these regions are composed of very small, thin-walled cells containing aleurone grains and fixed oil.

**Powdered Drug.**—Pale brown, weak yellow or light olive green. Numerous fragments of seed coat with red to orange colored polygonal cells, as observed in surface view; fragments containing dark brown stone cells with greatly lignified walls, and small lumen containing a silica nodule; very numerous fragments of perisperm and endosperm, the cells filled with small starch grains from 1 to  $4\mu$  in diameter or containing one or more prisms of calcium oxalate from 10 to  $25\mu$  in diameter; fragments of pericarp tissue with large celled parenchyma and spiral tracheæ and accompanying slightly lignified fibers, relatively few.

**Constituents.**—From 3 to 7 per cent. of volatile oil (**Cardamom Oil N.F.**) containing terpineol, terpinyl acetate, cineol, borneol and probably sabinene; fixed oil, protein, calcium oxalate and silica.

**Uses.**—Carminative, aromatic, condiment, and flavoring agent in curries, various food products, as an ingredient in a number of ground spice seasonings for meats and in some formulas for whole, mixed pickling spice.

**Average Dose** (unof.).—1 Gm. (15 grains).

**Preparations.**—Compound Cardamom Tincture, U.S.P., 4 cc. (1 fl. dr.); Aromatic Powder, N.F., 1 Gm.; Aromatic Chalk Powder, N.F., 2 Gm.; Compound Gentian Tincture, U.S.P., 4 cc. (1 fl. dr.).

**Adulterants.**—Cardamom capsules are chiefly adulterated with immature fruits, mouldy or insect-infested fruits and Cardamom "Splits" (partially opened fruits). The principal adulterants of Cardamom seed are small pebbles, seeds of *Amomum* species and ground pericarps of Cardamom.

**Allied Drug.**—Grains of Paradise or Guinea grains consist of the dried ripe seed of *Aframomum Melegueta* (Roscoe) K. Schumann, a reed-like herb of western Africa. They are angularly round or ovate, reddish brown and papillose externally, whitish internally and possess a hot pepper-like taste. The pungency is due to a yellowish, oily substance called *paradol* which is chemically related to gingerol. Used to impart pungency to vinegar and liquors and as a carminative chiefly in veterinary medicine. An artificial ground black pepper substitute has recently appeared on the market consisting of a mixture of ground grains of paradise and coconut shells.

**Cardamom Oil, N.F.** is a volatile oil distilled from the seed of *Elettaria Cardamomum*. It is colorless or very pale yellow with an aromatic, penetrating and camphoraceous odor of cardamom and a persistently pungent, aromatic taste. Sp. gr. 0.917 to 0.947 at 25°C., ref. ind. 1.4630 to 1.4660 at 20°C. Stimulant; flavoring agent in cakes, sausages and pickles, in bitters and cordials; in perfumery. It enters into Compound Cardamom Spirit N.F. and Compound Vanillin Spirit N.F. Compound Cardamom Spirit enters into Compound Cardamom Elixir N.F.

#### MARANTACEÆ (ARROWROOT FAMILY)

Perennial herbs chiefly of tropical climes with fleshy rhizomes or tubers rich in starch content. The leaves are radical and cauline, usually long petioled, with a sheathing base and a pulvinus at the summit of the petiole. The inflores-

cence is a panicle or raceme bearing irregular trimerous flowers with a one celled ovary. Calcium oxalate occurs in the form of rod-shaped crystals.

#### ARROWROOT STARCH (AMYLUM MARANTÆ)

**Synonyms.**—Arrowroot, West India-, Jamaica-, Bermuda- and St. Vincent-Arrowroot, Maranta Starch.

**Botanical Origin.**—*Maranta arundinacea* Linné.

**Habitat.**—West Indies and northern part of South America.

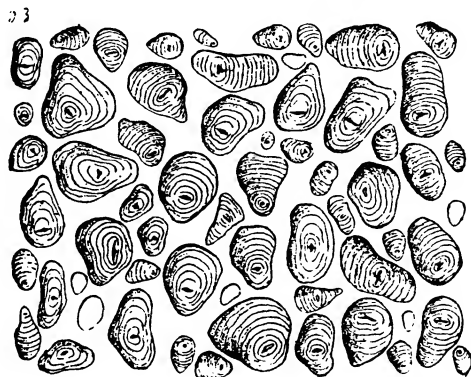


FIG. 97.—*Maranta* starch,  $\times 240$ . (From Greenish's *Microscopical Examination of Foods and Drugs*, after Greenish and Collin, J. & A. Churchill.)

**Plant.**—A perennial herb with a long, thick, fleshy rhizome growing to the height of 2–6 feet. The leaves are green, pubescent beneath, ovate-oblong to ovate-lanceolate with acute apex and rounded base. The flowers are white.

**Production and Commerce.**—The rhizomes are gathered from plants cultivated chiefly in Bermuda and the West Indies washed, beaten into a pulp and mixed with water and the starch separated by passing through copper sieves. The starch is then dried and placed in kegs which are exported from Bermuda and St. Vincent.

**Description.**—In whitish masses or granules up to 6 mm. in diameter (Bermuda) or 20 mm. (St. Vincent), velvety when rubbed between the fingers; starch grains ovoid, ellipsoidal, pear shaped or broadly spindle shaped from  $10\text{--}65\mu$  in diameter, hilum in center or toward broader end of grain and in the form of a transverse or two curved cleft resembling the wing of a bird in flight; lamellæ concentric and excentric but not as distinct as in potato starch. Polarization crosses distinct; the grains show a marked play of colors with the selenite plate.

**Uses.**—*Maranta* starch is employed as a nutrient in dietary preparations for infants and convalescents, also as an ingredient in certain brands of ice cream.

**Allied Products.**—The term arrowroot has been applied to a number of other starches. East Indian Arrowroot represents the starch obtained from *Curcuma angustifolia* and *C. leucorhiza* (Fam. *Zingiberaceæ*). Brazilian Arrowroot is the starch obtained from the Sweet Potato, *Ipomœa Batatas* (Fam. *Convolvu-*



*laceæ*) or from *Manihot esculenta* (Fam. *Euphorbiaceæ*). Queensland Arrowroot is the starch obtained from *Canna edulis* and other species of *Canna*. Tahiti Arrowroot is the starch obtained from *Tacca pinnatifida* (Fam. *Taccaceæ*). Portland Arrowroot represents starch prepared from various species of *Arum* (Fam. *Araceæ*). Florida Arrowroot is the starch obtained from *Zamia floridana* (Fam. *Cycadaceæ*).

### ORCHIDACEÆ (ORCHID FAMILY)

Perennial herbs of terrestrial or terrestrial saprophytic or epiphytic growth, having grotesque flowers. Roots fibrous to tuberous, often saprophytic in relation, or aerial with velamen. Stems and branches upright, in epiphytic types, often forming pseudobulbs. Leaves alternate, entire, parallel-veined, sheathing at base, rarely reduced to yellowish or pale scales in saprophytes. Flowers irregular, usually attractive, entomophilous, arranged in elongated spikes or racemes, trimerous. Sepals, 3 usually similar; petals 3 of which 2 often resemble sepals, third is variously, often greatly, modified and fused with 2 outer petaloid stamens as a labellum or lighting-board for insects. Third stamen of outer whorl fertile (*Orchideæ*) or a barren knob (*Cypripediæ*); pollen of fertile anther agglutinate as pollinia. Three stamens of inner circle barren and petaloid or one absent (*Cypripediæ*). Stamens all epigynous and often 3 are fused with the style as gynandrium. Carpels 3, syncarpous, with inferior, 3- rarely 4-, one-(usually) celled ovary. Fruit a capsule, 3-valved and one-celled. Seeds minute, abundant and wind disseminated.

### VANILLA N.F. (VANILLA)

**Synonyms.**—*Vanilla Bean*; *Ger. Fructus Vanilla*; *Fr. Vanille*.

**Botanical Origin.**—*Vanilla planifolia* Andrews (Mexican and Bourbon Vanilla) and *Vanilla tahitensis* J. W. Moore (Tahiti Vanilla).

**Part Used.**—The cured, full-grown, unripe fruit.

**Standard of Assay.**—Not less than 12 per cent. anhydrous extractive soluble in diluted alcohol.

**Habitat.**—In damp woods and forests of eastern Mexico and Tahiti.

**Plants.**—*Vanilla planifolia* is a perennial, climbing epiphyte which arises from soil roots by means of a fleshy, dark-green, succulent stem that attaches itself to the trunks and branches of trees by means of aerial rootlets. The leaves arise from the nodes of the stem in alternate fashion. They are ovate to ovate-lanceolate in shape, dark green and fleshy. The inflorescence is an axillary raceme bearing pale yellowish-green flowers. The fruit is a unilocular capsule containing numerous minute blackish-brown seeds and a blackish-brown pulp. *V. tahitensis* has narrower leaves and shorter fruits.

**Production and Commerce.**—In the eastern provinces of Mexico the Vanilla plants are mostly cultivated from cuttings or seeds. In order to secure a good crop of fruits, artificial pollination is practiced, this work being done chiefly by women who use a bamboo ladder to reach the flowers and a feather with which to carry the pollen from the male to the female plant. The plants bear fruit the

third year and continue until about 35 or 40 years old. The fruits are gathered in autumn as they commence to turn yellow. They are placed in heaps in sheds protected from rain and allowed to undergo a partial fermentation. They are then exposed to the sun or artificial heat and repeatedly sweated for a month or longer until a chestnut-brown color is noticed and the odorous principle, vanillin, has developed. They are then sun-dried for about 2 months, assorted according to length, coated with oil, tied in bundles of 80 to 120 beans with thread, wrapped, and shipped to the markets in tin cases, each holding about 40 pounds. The cultivation of the Vanilla plants also takes place in the Isle of

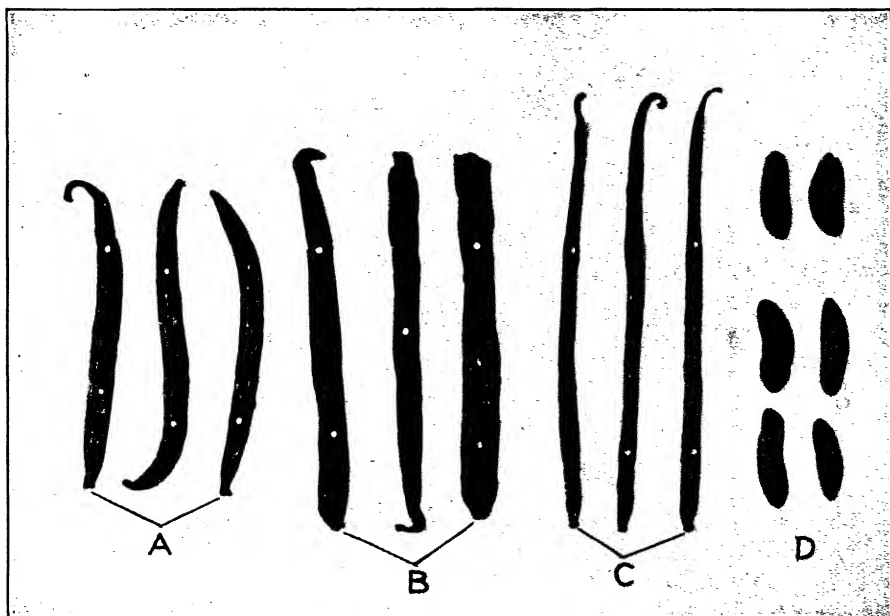


FIG. 98 —A, Tahiti Vanilla; B, Pompona Vanilla; C, Mexican Vanilla; D, Tonka seeds,  $\times \frac{1}{2}$ . (Photographed by W. J. Stoneback.)

Reunion, the Seychelles, Java, Madagascar, Hawaii, Tahiti, Martinique, the Dutch East Indies and Guadeloupe. **Mexican beans** are considered the best (see description), attaining a length of 30 to 35 cm. This variety is principally consumed in Mexico and the United States. **Bourbon or Reunion Vanilla**, from the Isle of Reunion, is about two-thirds as long as the Mexican variety, blacker in color, has a somewhat tonka-like odor, and its surface shows numerous needle-shaped crystals. The crop goes chiefly to France but some Bourbon Vanilla has been arriving in this country from Martinique. **Tahiti Vanilla**, grown in Hawaii and the isle of Tahiti, is reddish-brown in color, 12 to 14 cm. long, up to 9 mm. in width, broad in the middle and tapering toward either end. The capsules are twisted in the lower portion, truncate at the summit. *V. planifolia* beans are also produced in Tahiti and exported to the U. S.

**Mauritius Vanilla**, from the Seychelles, consists of cylindrical pods about 15 cm. in length, lighter in color than the Mexican and having but a faint odor.



The product goes chiefly to London. Vanilla Splits represent the fruits which are picked when more mature and show marked dehiscence.

**Vanilla splits and cuts** represent more mature fruits in which some dehiscence has occurred and which are frequently cut into short lengths.

The present commercial supplies of vanilla are shipped to this country mainly from Mexico City, Mexico, from Dominica, Tahiti, and Madagascar.

**Description.**—**Vanilla** occurs in the form of a linear, flattened capsule from 12 to 35 cm. in length and from 5 to 9 mm. in breadth: summit ending in a flat circular scar; gradually tapering toward both ends, base more or less curved or hooked with a circular scar; or in the Tahiti Vanilla, broad in the middle and tapering toward either end, the base closely resembling the summit; occasionally split into 3 parts near the tip; externally dusky brown to moderate brown, longitudinally wrinkled, moist-glossy; frequently with narrow, elliptical or irregular, somewhat wrinkled, dark-brown patches of cork; occasionally with an efflorescence of acicular crystals or monoclinic prisms of vanillin; soft leathery and flexible; unilocular, containing a brownish black pulp with many minute blackish-brown seeds therein imbedded. The odor is characteristically aromatic and fragrant and the taste agreeably aromatic.

**Microscopical Characteristics.**—Transverse sections of the capsules of Vanilla show the following characteristics, passing from periphery toward the center:

1. **Epicarp**, consisting of *epidermis* and *hypodermis*. The *epidermis* consists of a layer of thick-walled epidermal cells whose outer walls show the presence of a thin yellow cuticle. Stomata are present in this tissue. The epidermal cells contain protoplasm and red to brown bodies. Some also contain small prisms of calcium oxalate and a few, vanillin crystals. The *hypodermis* is composed of one to several layers of collenchymatic cells with dark-colored contents. Its cells are somewhat larger than those of the epidermis and thicker-walled.

2. **Sarcocarp**, a broad region of somewhat loosely arranged, large, deeply undulate parenchyma cells, becoming smaller in the inner zone of this region. Most of these cells are thin-walled and deeply undulate and contain brownish contents and oily globules but some possess bundles of long raphides of calcium oxalate up to  $400\mu$ . Some of the parenchyma cells of this region are thick-walled and possess long, oblique, slit-like pores, others broad, spiral, band-like thickenings. An interrupted circle of leptocentric fibrovascular bundles, each showing a central phloem more or less surrounded by a few spiral or pitted tracheæ will be seen coursing through the mesocarp. Surrounding each bundle will be noted a circle of sclerenchyma fibers with thin, strongly lignified walls and numerous transverse simple pores. If the section be mounted in phloroglucin solution (5 per cent.) and a drop of strong sulfuric acid is added, a carmine-red color will be observed, showing the presence of vanillin in this region.

3. **Endocarp**, an irregular line of inner epidermal cells which is differentiated into two regions, the *interplacental region* and the *placental region*. The interplacental (inner) epidermis shows its cells elongated into numerous thin-walled, nearly straight, glandular hairs which contain an abundance of gummy resinous

secretion; the placental region covers the six bifid *placentæ* which extend into the cavity of the capsule. Its (inner) epidermis is composed of mucilaginous cells.

4. **Seeds.**—These are minute blackish to reddish, irregularly triangulate bodies attached to the placental twigs of the *placentæ*. They are embedded in a dark-colored balsamic fluid secreted by the glandular hairs of the endocarp. Some of them may have been torn off in cutting the section. If some of these are mounted in chloral hydrate solution and examined they will be found to possess a strongly reticulate seed coat.

**Powdered Drug.**—The color is blackish-brown. The histological elements to be observed include fragments of the interplacental region characterized by unicellular glandular hairs containing globules of balsam, sclerenchymatous fibers with thick lignified walls and simple pores, tracheæ with pitted or spiral markings, polygonal stone cells of seed coat, fragments of parenchyma of the mesocarp with simple pores, or long oblique slit-like walls, or broad spiral bands, and calcium oxalate crystals in raphides up to  $400\mu$  in length and in monoclinic prisms up to  $35\mu$  long. Upon treating the powder with phloroglucin solution and hydrochloric acid it takes on a carmine-red color, due to the presence of vanillin.

**Constituents.**—*Vanillin* ( $C_8H_8O_3$ ) (an odoriferous, crystalline principle) 1.5 to 3 per cent.; balsam, resin, sugar, fixed oil, etc. Vanillin occurs in the balsamic fluid formed in the hairs of the endocarp. This fluid is secreted into the cavity of the fruit and, upon curing, permeates the whole fruit, the vanillin crystallizing out in the form of needles. Vanillin also occurs in Benzoin, Balsam of Peru, Balsam of Tolu, Asafoetida and other drugs. It is produced commercially from eugenol and from coniferin. Some Tahiti Vanilla also contains *anisyl alcohol*.

**Storage.**—Vanilla should be stored in a cool place in tight containers where it will not become brittle. Brittle vanilla should not be used.

**Use.**—Flavoring agent.

**Preparation.**—Vanilla Tincture.

**Adulterant.**—The powdered drug has frequently been adulterated with powdered Tonka, the powdered ripe seeds of *Dipteryx odorata* (Dutch Tonka) and *D. oppositifolia* (English Tonka). Tonka contains an aromatic principle known as coumarin, fixed oil, starch and aleurone. It may readily be detected microscopically in powdered Vanilla both by its spheroidal, eroded starch grains, which range from  $4-8\mu$  in diameter, and by examination of the crystals from a sublimate of a suspected sample on the thermo-stage. Coumarin melts at from  $54-56^\circ C$ . while vanillin melts at between  $81-83^\circ C$ .

**Vanillin U.S.P. (Vanillinum)** is the methyl ether of protocatechuic aldehyde. It may be obtained from Vanilla or produced synthetically from coniferin, a glucoside occurring in the lignified walls of plants and abundant in wood, or from eugenol. It occurs in fine, white to slightly yellow crystals, usually acicular. It is freely soluble in alcohol. It is used as a flavoring agent.

**Preparations.**—Compound Vanillin Spirit, Compound Vanillin Elixir (from Compound Vanillin Spirit), both in N.F.

**Allied Drugs.**—**Vanillons**, the fruit of wild plants of *V. planifolia*, are up to 12 cm. long and from 1.5 to 2.5 cm. in diameter, more or less triangular in out-

line, tapering toward both ends, reddish-brown to dark brown in color, often showing transverse markings and dehiscence. They possess a heliotrope-like odor, due to a phenol aldehyde, *heliotropin*. These fruits are employed in the flavoring of tobacco and manufacture of certain sachets.

**Pompona Vanilla**, from Guadeloupe, consists of the fruits of *Vanilla pompona*, which resemble Vanillons in appearance.



FIG. 100.—Cypripedium. Dried rhizome and roots.  $\times \frac{7}{12}$ . (Photograph by Stoneback.)

#### CLASS B—DICOTYLEDONEÆ

Plants having the following characteristics:

Two-seed leaves (cotyledons) in embryo.

Netted-veined leaves.

Stems, and roots of secondary growth with open collateral fibrovascular bundles, in stems, radially arranged about pith.

Exogenous stems.

Medullary rays present.

Cambium present.

Roots developing secondary structure.

Flowers tetramerous or pentamerous (parts of each whorl, 4 or 5 or multiples thereof).

#### SUB-CLASS A—ARCHICHLAMYDEÆ

Those dicotyledonous plants in which the petals are distinct and separate from one another or are entirely wanting. That group of the Archichlamydeæ whose flowers show the absence of petals and frequently of sepals is called the *Apetalæ*. The group whose plants have flowers showing the parts of their corolla (petals) separate and distinct is called the *Choripetalæ*.

## PIPERACEÆ (PEPPER FAMILY)

A family of erect or climbing aromatic herbs and shrubs with jointed stems, alternate, or rarely verticillate or opposite leaves without stipules or with stipules adnate to the petiole, and spiked, inconspicuous, wind-pollinated flowers. The flowers possess a superior, 1-celled, 1-ovuled ovary with an erect ovule. The vascular bundles in the stems are more or less scattered as in stems of Monocotyledons. The characteristic fruit is a drupe enclosing a single upright seed, with abundant perisperm (from megasporangial tissue), reduced endosperm (from matured embryo sac) and a very small embryo.

## CUBEB N.F. (CUBEBA)

**Synonyms.**—Cubebs, *Cubeb-berries*, Tailed Pepper; *Ger.* Kubeben; *Fr.* Cubèbe.

**Botanical Origin.**—*Piper Cubeba* Linné filius.

**Part Used.**—Dried, nearly full-grown, unripe fruit.

**Limit of Impurities.**—Not more than 10 per cent. of its shrivelled and immature fruits, not more than 5 per cent. of the stems of the plant, and not more than 2 per cent. of foreign organic matter other than shrivelled and immature fruits and stems. It yields not more than 2 per cent. of acid-insoluble ash.

**Standard of Assay.**—Not less than 13 cc. of volatile Cubeb oil from each 100 Gm. of drug.

**Habitat.**—Java, Sumatra and Borneo. Cultivated in Java, Sumatra, Ceylon and West Indies.

**Plant.**—A climbing perennial vine having a woody, jointed stem that roots at the joints and bears alternate, coriaceous, petiolate leaves and diœcious flowers in spikes; fruit a globular drupe, which when young is sessile but as maturation proceeds is gradually elevated on a slender stalk (*thecaphore*) formed by a basal development of the pericarp of the fruit.

**Production and Commerce.**—The plants are grown on special and coffee plantations, being planted against shade trees for support. The fruits, numbering up to 50 or more on each spike, are gathered while still green but nearly full-grown and dried in the sun. They are then taken to Batavia and Singapore from whence the commercial supplies are exported in bags. The article used in this country usually comes direct from Singapore and the Dutch East Indies.

**Description.**—Drupe globular from 3 to 6 mm. in diameter, with a straight, slender stem-like portion seldom exceeding in the unripe fruit 7 mm. in length; apex with remains of 4 stigmas; pericarp dusky red, moderate brown or rarely grayish and coarsely reticulate; one chambered, one seeded; the reddish-brown seed attached to base of pericarp and usually not completely filling the locus; odor aromatic; taste characteristically aromatic and pungent.

**Microscopical Characteristics.**—Passing from periphery toward the center, the following structures are noted in microscopic sections:

1. An *epicarp* of tabular epidermal cells having thick, wavy outer walls and olive-green contents; beneath this

2. A *hypodermis* of thick-walled stone cells with yellowish, porous walls, some of which are interrupted by intervening parenchyma cells.
3. A few layers of collapsed cells.
4. A broad zone of *parenchyma cells*, scattered among which are numerous large, ovoid *secretion cells* containing a volatile oil and occasionally short, rod-shaped crystals. The contents of these secretion cells are colored a purplish-red with sulfuric acid.

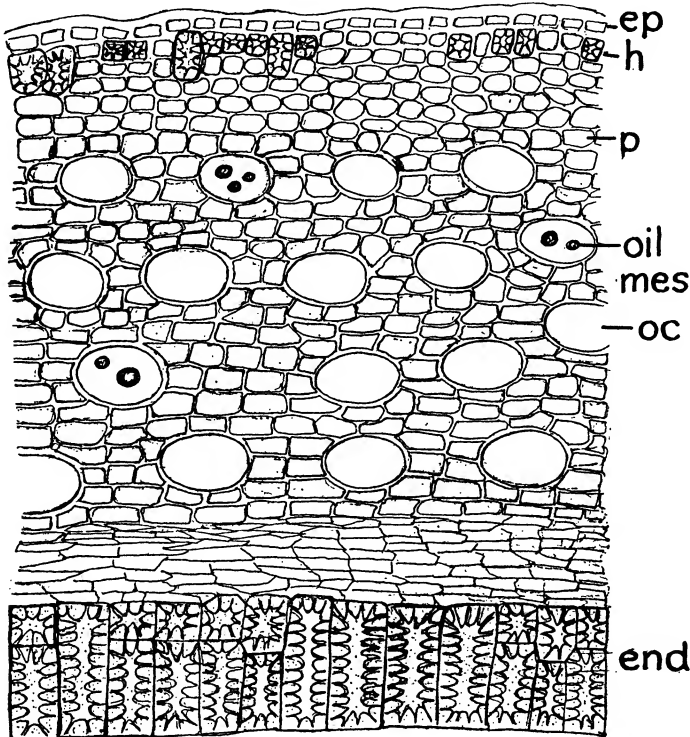


FIG. 101.—Cubeba. Cross section of pericarp (highly magnified). *ep*, epicarp; *h*, hypodermis with interrupted layer of stone cells; *mes*, mesocarp; *p*, parenchyma; *oc*, oil cell; *end*, endocarp of stone cells.

5. A zone of *collapsed parenchyma cells* in which occur a few small collateral bundles.
6. An *endocarp* of one or two rows of radially elongated stone cells with very thick porous walls.
7. A *spermoderm* of several rows of reddish-brown, tangentially elongated, more or less collapsed cells.
8. A broad *perisperm* consisting of numerous thin-walled, somewhat polygonal-shaped cells containing either small starch grains or globules of fixed oil, or, occasionally, a crystal of calcium oxalate.
9. A small *endosperm* (not diagnostic) near the apex of seed.
10. A minute *embryo* imbedded in the endosperm (not diagnostic).



**Powdered Drug.**—Moderate yellowish brown to dusky brown, becoming when mixed with a drop of sulfuric acid on glass, and viewed downward against a white background purplish red. This color reaction may or may not occur instantly. Fragments of hypodermis with numerous nearly isodiametric or slightly elongated, thick-walled, porous stone cells with yellowish walls; fragments of endocarp with radially elongated, larger stone cells with yellow, greatly

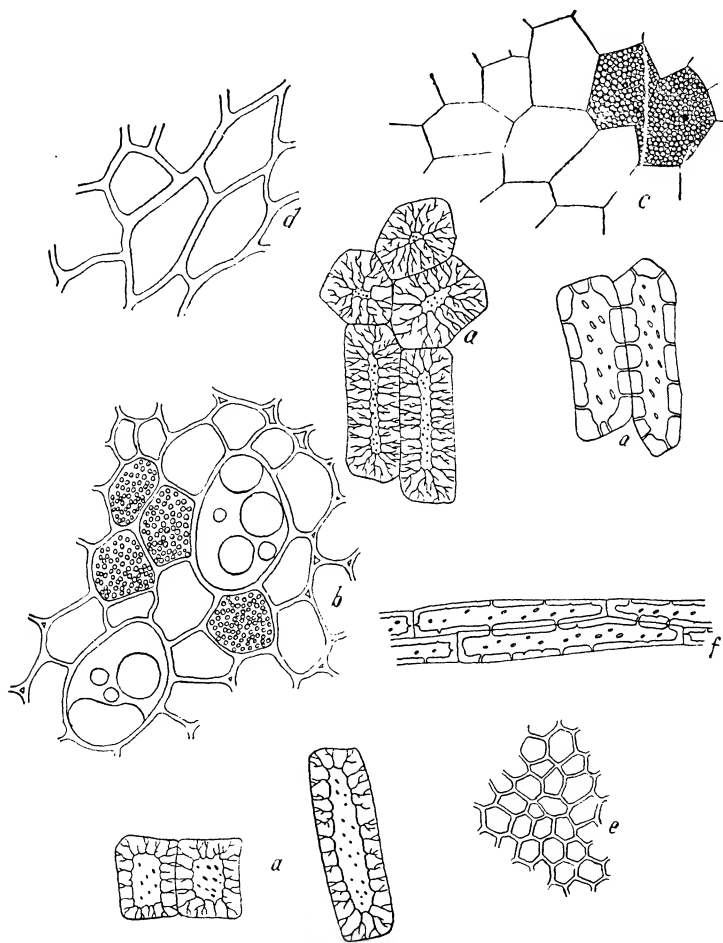


FIG. 102.—Powdered Cubeba. (a) Stone cells; (b) endosperm, with oil globules and proteid granules; (c) cells of perisperm; (d) parenchyma of stalk; (e) epidermal cells, vertical view; (f) tracheids. (After Schneider.)

thickened, lamellated, porous walls and dark lumina; fragments of perisperm some of the cells of which are filled with small starch grains, others with oil; starch grains simple or 2-compound, the individual grains varying from  $2\mu$  to  $12\mu$  in diameter; fragments of parenchyma, some of the cells of which contain reddish brown tannin contents, others with oil contents and suberized walls; fragments of wood bundles few, with spiral tracheæ and thick-walled, strongly

lignified, sclerenchyma fibers, the latter with blunt, rounded or attenuated ends and up to 1 mm. in length.

**Constituents.**—Up to 18 per cent. of *volatile oil* containing a sesquiterpene hydrate known as cubeb camphor; up to 3.5 per cent. of *cubebic acid*, which is colored purplish red with sulfuric acid; a bitter principle called *cubebin* which is colored cherry red with sulfuric acid; resins, fixed oil, gum and starch.

**Uses.**—Diuretic, expectorant and genito-urinary antiseptic.

**Average Dose.**—2 Gm. (30 grains.)

**Preparation.**—Cubeb Oleoresin, 0.5 Gm. (7½ grains).

**Adulterants and Substitutes.**—(1) Fruits of *Piper ribesoides* which are light gray to dark brown, 5 to 8 mm. in diameter, have long, stem-like portions up to 14 mm. in length, isodiametric or nearly isodiametric stone cells in the endocarp, and give a brownish coloration with sulfuric acid. (2) Fruits of *Piper cubeba* var. *rinæ badak* which are grayish, 3 to 6 mm. in diameter, with stem-like portion about 5 mm. in length; have stone cells scattered through parenchyma and give a dark brown coloration with sulfuric acid. (3) Fruits of other allied species of *Piper*, all of which thus far examined give a greenish to brown coloration upon crushing and adding sulfuric acid. (4) Superfluous rachis and stems. (5) Fruits of *Embelia ribes*, an Indian tree belonging to the *Myrsinaceæ*. These resemble somewhat black pepper drupes but contain embelic acid which, in alcoholic solution, is colored red with ammonia. (6) Mature fruits of *Piper Cubeba* which are low in oil yield.

#### PEPPER (PIPER)

**Synonyms.**—Black Pepper, Pepper Corn; *Ger.* Schwarzer Pfeffer; *Fr.* Poivre noir.

**Botanical Origin.**—*Piper nigrum* L.

**Part Used.**—Dried unripe fruit.

**U.S. Dept. of Agriculture Standard of Purity.**—S.R.A.F.D., 1936, specifies not less than 6.75 per cent. of non-volatile ether extract, not more than 7 per cent. total ash and 1.5 per cent. acid-insoluble ash.

**Habitat.**—Southern India. Cultivated in the Madras Province of India, Singapore, the Acheen and Lampong districts of Sumatra, Ceylon, French Indo-China, Siam, Rioux-Lingga Archipelago, South America and the West Indies.

**Plant.**—A perennial climbing or trailing woody vine that has coriaceous, grayish-green, petiolate, broadly ovate to suborbicular, evergreen leaves with 3 prominent middle nerves and 2 lateral nerves; the flowers are whitish, perfect, and arranged on elongated spikes; the fruit is a globular drupe of a red color when ripe.

**Production and Commerce.**—The Pepper vine is extensively cultivated in the Madras Presidency of India, around Singapore, in Sumatra, Siam and French Indo China, trees being planted to provide the requisite support and shade for its growth. The fruits are developed on spikes which are cut from the vines as soon as the lowest drupes on the axis begin to change in color from green to red. The entire spikes bearing unripe fruits are then dried in the

sun or over fires, after which the fruits are separated from the rachis, garbled and placed in bags for shipment. A number of grades of black pepper are found on the markets. These are named after the ports of shipment or regions of growth, viz.: Singapore, Tellicherry, Siam, Penang or Acheen, Alleppy,

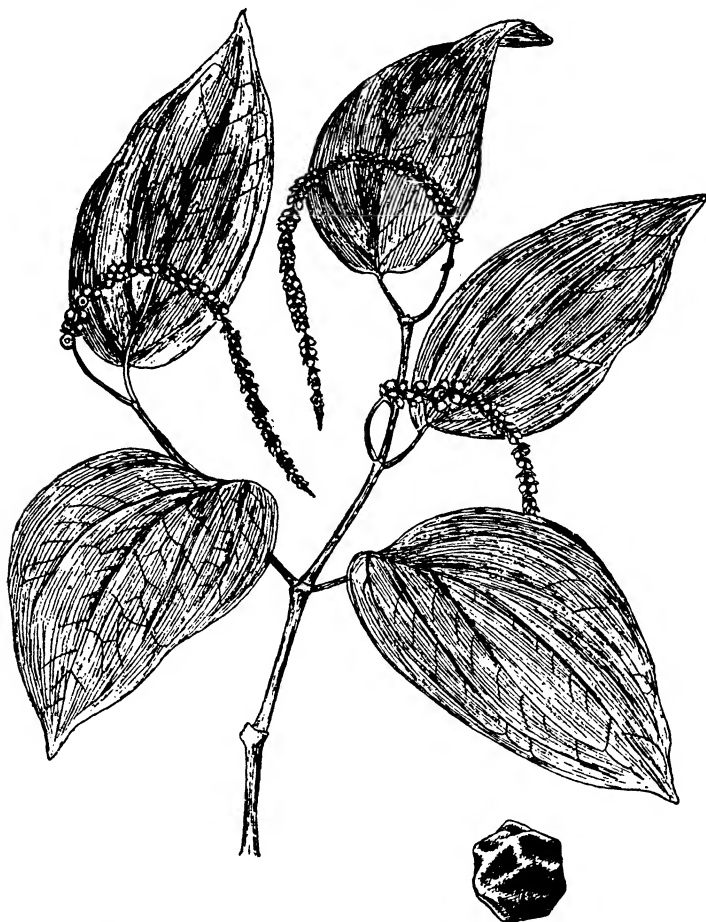


FIG. 103.—*Piper nigrum*—Branch and fruit. (Sayre.)

Lampong, etc. The best grades are fire-dried and possess a smoky odor and taste. Of these the large, dark reddish brown, sharply aromatic Tellicherry and Alleppy and the smaller, shriveled but pungent Singapore appear to be in most esteem. Most of the drug recently imported into the United States came from India and the Netherlands Indies. During 1946, 9,661 lbs. of unground black pepper and 1,621 lbs. of unground white pepper were imported into this country.

Acheen pepper has frequently represented the poorest grade, many samples consisting of small, light-weighted fruits often admixed with pepper shells, dirt and small stones.

**Physical Characteristics.**—In entire nearly globular drupes, 6 mm. or less in diameter; grayish, brownish or black; surface coarsely reticulate; one-seeded;

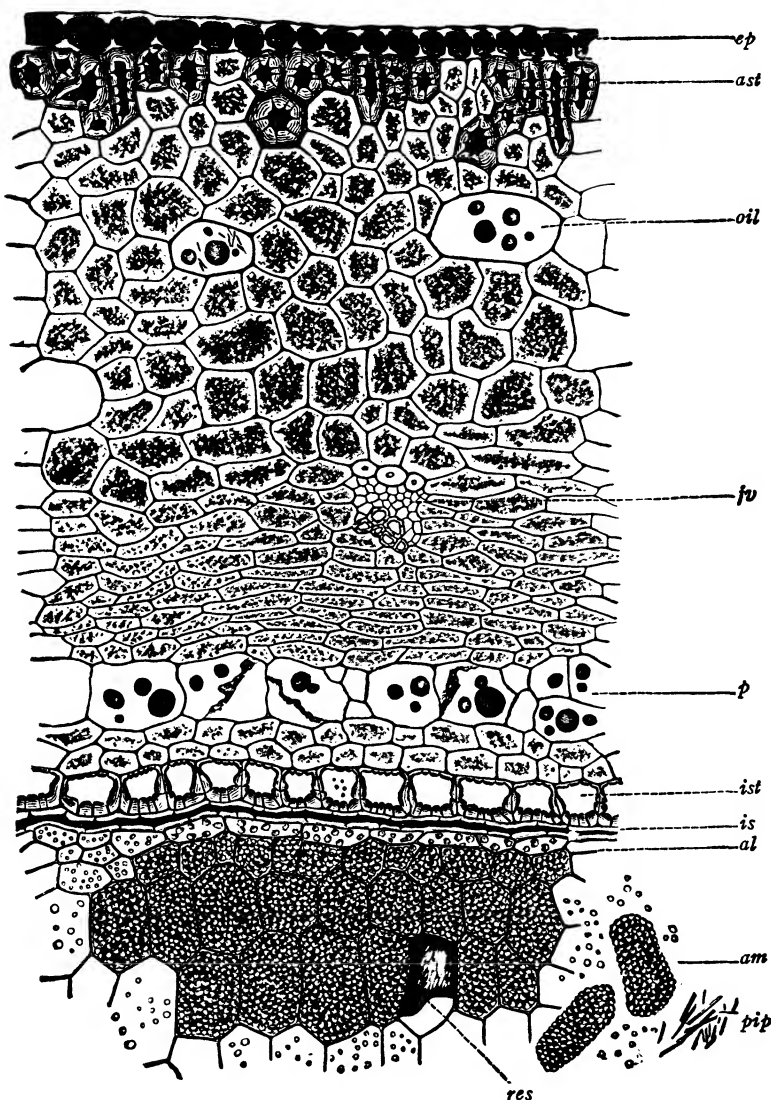


FIG. 104.—Black Pepper. Transverse section of representative outer portion of fruit. Pericarp consists of *ep* epicarp, *ast* hypodermal stone cells, *oil* outer mesocarp with oil cells. *fv* bundle zone containing an interrupted circle of collateral fibrovascular bundles, *p* an almost continuous layer of large oil cells in inner mesocarp, and *ist* endocarp of "beaker cells;" spermoderm consists of *is* outer epidermis, and inner layers (not shown); perisperm consists of *al* aleurone cells and reserve parenchyma, most of the cells containing starch masses (*am*), a scattered number, oleoresin (*res*) and needle-shaped crystals of piperin (*pip*). (From *Win- ton's "Microscopy of Vegetable Foods,"* John Wiley & Sons, Inc., after Moeller.)

seed nearly white, hollow and adhering to the pericarp; odor aromatic; taste aromatic and strongly pungent.

**Microscopical Characteristics.**—Transverse sections made through the soaked fruit show the following structural peculiarities: (see Fig. 104).

1. **Epicarp**, consisting of (a) an outer layer of polygonal cells having a distinct cuticle and containing dark-brown to blackish contents, and (b) a zone varying in thickness of from 2 to 3 layers and composed of thin-walled parenchyma cells intermingled with greatly thickened isodiametric to radially elongated stone cells. This region is termed by some authors the hypodermis.

2. **Mesocarp**, a comparatively broad zone constituting the greater area of the pericarp. The outer 7 or 8 layers of cells are for the most part parenchymatous and contain small starch grains and chlorophyll. Scattered here and there among these cells will be noted larger secretion sacs with suberized walls and oil or resin contents. The next several layers of cells appear more or less compressed and it is through this region that fibrovascular bundles ramify. Beneath the region of compressed cells will be noticed a layer of large oil cells having suberized walls and then a zone of two layers of small parenchyma cells.

3. **Endocarp**, consisting of a single layer of stone cells ("beaker cells") whose radial and inner walls are more strongly lignified than the outer ones.

4. **Spermoderm**, consisting of 2 or 3 layers of compressed, elongated cells beneath which is a pigment layer containing a dark-brown tannin substance that takes the blue color with ferric chloride solution.

5. **Perisperm**, of 3 regions, viz.:

(a) An outer layer of clear thin-walled cells called the "hyaline layer."

(b) An aleurone zone of 2 or 3 layers of cells containing protein granules.

(c) A broad zone of radially elongated, reserve parenchyma cells containing masses of minute starch grains imbedded in protein substance. The individual grains are more or less polyhedral in outline and have a diameter of 1-6 $\mu$ . Scattered among the cells of this region are somewhat rounded oleoresin cells containing globules of oil, masses of resin and *piperine*. The last-mentioned substance can best be studied by mounting sections in alcohol, then allowing the alcohol to evaporate and remounting in water.

In the center of this zone a cavity 1 mm. or more in diameter will be noted.

6. **Endosperm**, a very small region of thin-walled cells and only seen when sections are cut through the upper part of the seed.

7. **Embryo**, very minute and imbedded in the endosperm.

Sections mounted in sulfuric acid display a deep red color due to piperine.

**Powdered Drug.**—Dark gray. The chief diagnostic elements in the ground or powdered drug are (1) compact masses of minute starch grains, composed of individual grains, rounded to angular in outline and 1-6 $\mu$  in diameter, and oval aggregates; (2) stone cells of epicarp, varying from isodiametric to more or less columnar to irregular shaped with thick porous walls and reddish-brown contents, and (3) horseshoe-shaped stone cells of endocarp ("beaker cells") having usually thin outer walls and thickened radial and inner walls. Other histological elements include fragments containing the oil cells with brownish suberized

walls, yellowish oil globules and needle-shaped piperine crystals. The latter frequently separate from oil globules.

**Constituents.**—A crystalline, feebly basic principle called *piperine* which yields on hydrolysis the colorless liquid alkaloid *piperidine* and *piperic acid*;

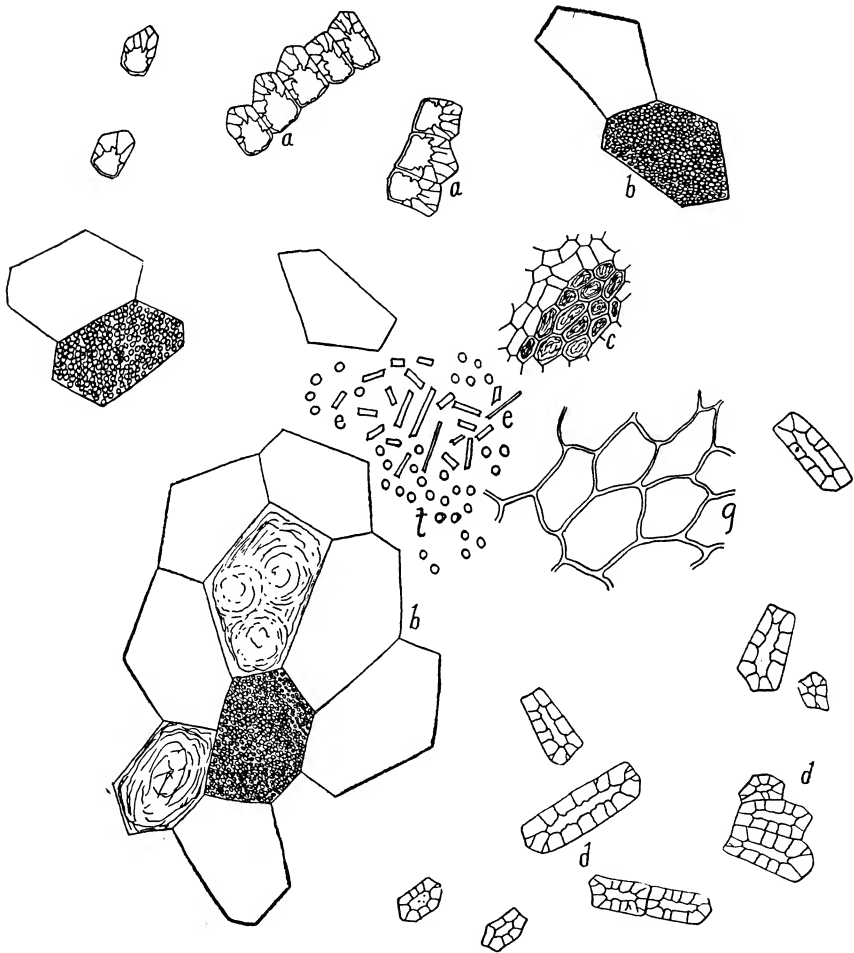


FIG. 105.—Powdered Black Pepper. (a) Stone cells with unequally thickened walls (b) perisperm tissue with starch and resin; (c) epidermal cells; (d) typical stone cells; (e) crystals of piperine; (f) starch granules; (g) pericarp parenchyma. (After Schneider.)

*acid*; a yellowish aromatic *volatile oil*, a very pungent isomeride of piperine termed *chavicine*; starch, resin and proteins.

**Uses.**—Chiefly as a culinary spice, rarely in medicine as an aromatic, stomachic or carminative. Whole pepper is a constituent of whole mixed pickling spice.

**Average Dose.**—0.5 Gm. (8 grains).

**Adulterants.**—Whole black pepper has been adulterated with pepper hulls, consisting of the broken outer portions of the pericarp of the ripe fruit, a by-product in the preparation of white pepper. These are grayish-black in color and when sectioned show numerous characteristic stone cells of the epicarp.

**Acheen Peppers** (see Commercial).

Powdered black pepper has been adulterated with the following substances: Ground nutshells, buckwheat hulls, cocoa shells, leguminous seeds, pepper hulls, pepper stems, exhausted spices, cereals, mustard hulls, olive pits, flaxseed and sawdust. Charcoal has been added to light colored, fraudulent mixtures of pepper and adulterants, to bring up the color and capsicum to give necessary pungency.



FIG. 106.—Long Pepper. Whole spice.  $\times 1\frac{1}{4}$ .

*Arancini*, the small fruits of the sweet orange. These are about 10 mm. in diameter and have been recently found in ground form as an admixture in powdered black pepper. Their presence may be detected by treating the suspected powder on a slide with 4 per cent. sodium hydroxide solution, washing with water, adding a drop of Congo-red solution and removing excess of stain by washing with water. Red-colored cells and closely arranged spiral tracheæ, the latter appearing as a scalariform mass, indicate arancini.

A recent factitious substitute for powdered black pepper has appeared on the market, consisting of a mixture of powdered Grains of Paradise and Coconut shell charcoal.

**Allied Products.**—*White pepper* is the dried mature berry (more properly, drupe) of *Piper nigrum* L. from which the outer coating, or the outer and inner coatings have been removed. This is accomplished by macerating the ripe fruits in water to loosen the dark hull, subsequently removing it by bruising and friction, and afterwards drying the product. Whole white pepper is gray to light yellowish gray, subglobular, with a smooth to longitudinally striated surface. *Decorticated White Pepper* consists of the larger sized black pepper

fruits from which the outer black coat only has been removed by machines. It is used in the seasoning of mayonnaise and some other food products. It contains not less than 7 per cent. of nonvolatile ether extract, not less than 52 per cent. of starch, not more than 5 per cent of crude fiber, not more than 3.5 per cent. of total ash, nor more than 0.3 per cent. of ash insoluble in hydrochloric acid. (U.S. Dep. Agr. Standard.)

*Long Pepper* is the dried entire spike of immature fruit of *Piper longum* L., a shrub indigenous to Bengal and the Philippine Islands, and *Piper retrofractum* Vahl (*P. officinarum* C.DC.), a shrub indigenous to the Malay Peninsula.

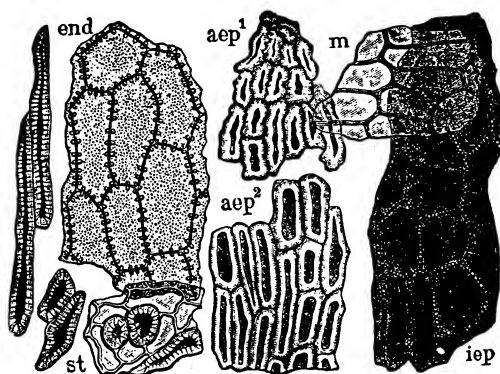


FIG. 107.—Ground Long Pepper (*Piper retrofractum*). Elements in surface view. *st*, stone cells of hypodermis; *end*, endocarp. Spermoderm: *aep*<sup>1</sup> and *aep*<sup>2</sup>, outer epidermis at apex and on body of kernel; *m*, middle layer; *iep*, inner epidermis.  $\times 160$ . (From Winton and Winton, "Structure and Composition of Foods," John Wiley & Sons, Inc.)

This compound fruit is subcylindrical, up to 40 mm. long, about 5 to 7 mm. thick, of a grayish black color and composed of numerous small immature drupes and bracts imbedded spirally in the axis. Its taste and odor somewhat resemble black pepper but are distinctive and less strong. It contains about 1 per cent. of volatile oil, 6 per cent. of piperine, a pungent resin termed chavicin and starch. It is used as a spice in pickling.

Powdered long pepper has occasionally been found as an adulterant and substitute for powdered black pepper. Its diagnostic elements are large, elongated, porous, sclerenchyma cells of the endocarp, polygonal and rounded starch grains from 2 to 10 $\mu$  in diameter, and averagely larger than those of black pepper, and masses of starch and chlorophylloid parenchyma from the mesocarp devoid of oil cells. The absence of oil cells and "beaker cells" together with the presence of larger starch grains and typical sclerenchyma cells distinguish this article from powdered black pepper. (See Fig. 107.)

#### SALICACEÆ (WILLOW FAMILY)

A family of anemophilous shrubs or trees of temperate or cold regions, including the Willows and Poplars, whose bark often contains bitter principles (salicin, etc.). Leaves alternate, simple, deciduous, entire, stipulate; stipules rarely



green, persistent, usually functioning as winter bud-scales and falling in spring. Inflorescences dioecious spikes, so on separate plants. Staminate spikes forming deciduous catkins of yellowish flowers, pistillate as persistent spikes of green flowers. Flowers of catkins numerous, each of 2 to 5 (Willow) or 6 to 15 (Poplar); stamens in axil of a small bract leaf, sometimes with small nectar knob or girdle at base. Pistillate flowers green, each of a bicarpellate pistil in axil of bract, ovary one-celled with parietal placentation, style simple, stigma bilobed. Fruit a capsule dehiscent longitudinally. Seeds small, exalbuminous, surrounded by a tuft of hairs arising from the funicle for dissemination.

Microscopically, the plant axis is characterized by the occurrence of isolated groups of sclerenchyma fibers in the pericycle, the presence of layers of hard and soft bast in the phloem, the superficial development of cork, narrow medullary-rays in the wood and tracheæ with simple pores. In several species of *Populus* stone cells occur in the primary cortex, forming a ring in *P. alba*. In this species stone cells also occur in the hard bast. Calcium oxalate occurs in the form of solitary crystals, crystal-fibers and rosette aggregates. The leaves frequently show stomata on both surfaces with parallel neighboring cells. The epidermis often shows mucilaginous modification of the inner, occasionally the outer wall of its cells. Glandular hairs are absent. Non-glandular hairs are abundant and are unicellular in character. The glycoside salicin N.F., occurring in the bark of many species of *Salix* and *Populus*, imparts a red color to sulfuric acid.

#### WILLOW (SALIX)

**Synonyms.**—Willow Bark, Cortex Salicis, White Willow, European Willow; *Ger.* Weidenrinde; *Fr.* Saule blanc.

**Part Used.**—The dried stem bark.

**Botanical Origin.**—*Salix alba* L.

**Habitat.**—Europe. Naturalized sparsely in North America.

**Plant.**—*Salix alba* is a large tree with a short trunk, yellowish-brown branches and elliptic-lanceolate, acuminate and serrulate, ash-gray, sericeous leaves. The fruit is a capsule dehiscent by 2 valves and containing numerous seeds each with a basal tuft of hairs.

**Production.**—The wood of this species is used for chip boxes. The bark is stripped from the branches during the spring when it contains the most salicin and rapidly dried. The bark from two to three year old branches is preferred. The commercial drug frequently represents other species.

**Description.**—It occurs in flat pieces or quills 1 to 2 cm. in width and of varying length; outer surface in young bark smooth, greenish-brown, in older bark dull, yellowish-brown to dark brown, irregularly wrinkled; inner surface, cinnamon brown to pale reddish, longitudinally striated; fracture short fibrous, odor slightly aromatic; taste astringent and slightly bitter.

**Histology.**—The diagnostic microscopical features of this bark include the feebly developed cork, the outer walls of the cells of which are strongly thickened; a cortex, collenchymatous in its outer region and containing starch parenchyma, tannin cells and rosette aggregates of calcium oxalate, alternating

tiers of bast fibers in the phloem surrounded by crystal fibers containing rhombohedral crystals of calcium oxalate. No stone cells are found in the phloem.

**Constituents.**—Tannin and *salicin* (glycoside). Salicin ( $C_{13}H_{18}O_7$ ) is a glycoside obtained from several species of *Salix* and *Populus*. It is hydrolyzed by *emulsin* in the presence of water to form saligenin and dextrose.

**Uses.**—White Willow bark is an astringent and simple bitter but has occasionally been used by the laity in the form of an infusion for ague and rheumatism.

**Allied Drugs.**—**Black Willow** is yielded by *Salix discolor* Muehl. and *S. nigra* Marsh. It occurs in elongated, thin, fibrous strips with wrinkled cork (*S. discolor*) or in thicker strips (*S. nigra*) with a reddish-brown inner surface. It contains salinigrin, salicin and tannin.

**Poplar bark** is the dried bark of the Silver Poplar or Great Aspen, *Populus alba* L. It contains the glycosides salicin and populin, the latter crystallizing in needles and yielding upon hydrolysis saligenin and benzoic acid.

**Salicin N.F. (Salicinum)** is a glycoside obtained from willows and poplars. It occurs in silky, shiny needles or in orthorhombic prisms which dissolve in  $H_2SO_4$  forming a red solution. Most of the commercial salicin appears to be obtained from barks of the shoots of *Salix fragilis* which is known as "rood score" or red bark and is obtained largely from Belgium. It contains about 3 per cent. of salicin. The bark of *Salix purpurea* L. contains up to 7 per cent. of salicin. One Gm. of salicin dissolves in about 25 cc. of water and about 90 cc. of alcohol at 25°C. Salicin is used as a simple bitter, antirheumatic and antiperiodic. Average dose, 1 Gm. or 15 grains.

#### POPLAR BUD N.F. (POPULI GEMMA)

**Synonyms.**—Balm of Gilead Buds, Tacamahac, Balsam Poplar Buds, Willow Poplar Buds.

**Botanical Origin.**—*Populus Tacamahacca* Miller (*Populus balsamifera* "Linné") (Balsam Poplar) and *Populus candicans* Aiton (Balm of Gilead).

**Part Used.**—The air-dried, closed winter leaf bud.

**Standard of Assay.**—Poplar Bud yields not less than 40 per cent of anhydrous alcohol-soluble extractive.

**Purity Rubric.**—Not more than 16 per cent. of flower buds of the plants yielding Poplar Bud, and not more than 2 per cent. of other foreign organic matter; it yields not more than 1 per cent. of acid-insoluble ash.

**Habitat.**—Northern United States and Canada.

**Plants.**—*Populus Tacamahacca*, commonly known as Balsam Poplar, or Tacamahac, is a tree, pyramidal in shape, which rises to the height of 45 to 90 feet. Its leaves are alternate, deciduous, ovate-lanceolate or cordate-ovate, smooth, serrulate, bright green on upper surface, whitened beneath. Leaf buds reddish-brown and covered with fragrant oleoresin. Its flowers appear in the early spring before the leaves have opened, and are arranged in long drooping catkins. Its fruits are small pods enclosing seeds covered with a cottony down.

*Populus candicans* Ait., the true Balm of Gilead, differs from the preceding species with which it has often been confused by not possessing the pyramidal habit of growth of the Balsam Poplar, its top being broad and spreading and by its leaves being broader and more cordate.

**Commercial.**—The commercial supplies of this drug come largely from Missouri, Michigan, North Carolina and Virginia.

**Description.**—Buds conical or pyramidal, pointed, up to 25 mm. in length and 15 mm. in thickness; externally weak reddish brown to moderate brown, glossy and glutinous when fresh, consisting of a few small leaves at the center toward the base, enclosed by about 15 oblong, pointed, concave, closely imbricated scales, the surfaces of which are covered with a thin layer of sticky

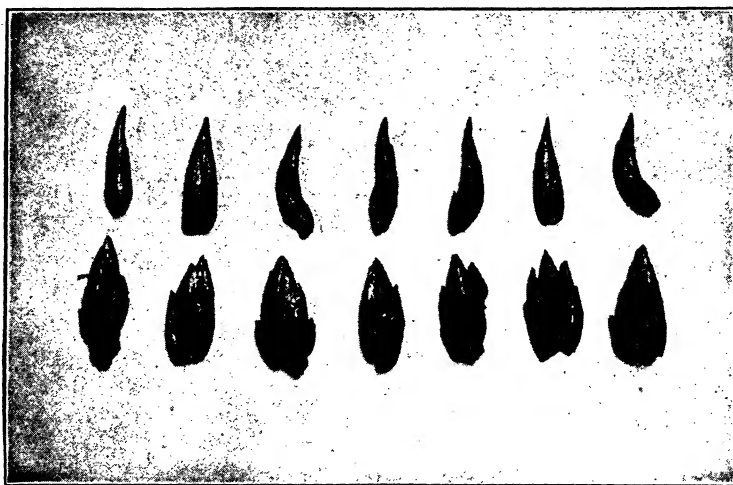


FIG. 108.—Poplar buds,  $\times \frac{3}{4}$ . (Photograph by Stoneback.)

oleoresin containing microscopic crystals of Salicin which display colors with polarized light; odor fragrant, balsamic; taste aromatic and bitter.

**Histology.**—Epidermal cells of bud scales polygonal in surface view, with heavily cutinized outer walls; hairs nonglandular, unicellular, conical, up to  $450\mu$  in length and  $15\mu$  in thickness, abundant on the outer surface (*P. Tacamahacca*) or along the margin (*P. candicans*); mesophyll parenchyma cells with reddish-brown to yellowish-orange oleoresinous contents and occasionally a rosette aggregate of calcium oxalate up to  $20\mu$  in diameter; stone cells in mesophyll numerous, up to  $25\mu$  in diameter, single or in groups (up to 20 cells in transverse sections of *P. candicans* and up to 80 cells in transverse sections of *P. Tacamahacca*).

**Constituents.**—*Volatile oil* consisting principally of *humulene*; *salicin*; a *balsamic resin*, mannite, fixed oil, gallic acid, etc.

**Adulterant.**—Flower buds of the same species which are thin and contain but 4 or 5 scales and small, immature flowers.

**Uses.**—Poplar buds are employed as a stimulant and expectorant in Compound Syrup of White Pine and other cough preparations.

**Average Dose.**—4 Gm. (60 grains).

**Preparations.**—Compound White Pine Syrup, 4 cc. (1 fl. dr.); Compound White Pine Syrup with Codeine, 4 cc. (1 fl. dr.).

#### CARBO LIGNI (WOOD CHARCOAL)

**Synonyms.**—Charcoal, Carbo Ligni Pulveratus, Soft Wood Charcoal; *Ger.* Holzkohle; *Fr.* Charbon de bois.

**Botanical Origin.**—Various soft-wooded genera, mainly *Salix* and *Populus*, *Acer*, and *Tilia*, e.g., the Willow, Poplar, Maple and Linden groups.

**Part Used.**—The charred wood. Ash.—Not more than 7 per cent.

**Production.**—Two methods are largely employed for the production of charcoal, viz. the “stack” and “retort” methods. Both of these are dependent on the principle that organic matter burnt without the access of air is carbonized.

The first of these methods, which dates from a remote period, consists of piling billets of wood on ends into a conical pile or stack and covering this with earth or sod, leaving several openings at the bottom and one at the top so that a draught may insure a proper beginning of combustion. A fire is started at the bottom of the stack and, when under way, the hole at the top is closed. As soon as the wood is all ignited the openings at the bottom are closed. The effect of this process is to drive off the volatile substances of the wood such as water, wood spirit, oxygen, etc., carbon alone remaining. In districts where wood is plentiful this method is frequently practised.

The modern method consists of burning wood without access of air in cast-iron retorts connected with condensers. This process insures the collection of valuable by-products such as tar, acetic acid, methyl alcohol, acetone, cresol, guaiacol, creosote, naphthalene, paraffine, etc.

**Description.**—A black odorless and tasteless powder which should be free from grittiness. If 0.25 Gm. of medicinal charcoal is boiled with 10 cc. of sodium hydroxide test solution and filtered, the filtrate should be colorless. A colorless filtrate indicates complete carbonization.

**Uses.**—Wood Charcoal is employed as an absorbent and deodorant. It is also a decolorizing agent. The U.S.P. permits activated charcoal to be dispensed when Carbo Ligni is prescribed.

**Average Dose.**—1 Gm. (15 grains).

#### ACTIVATED CHARCOAL U.S.P. (CARBO ACTIVATUS)

**Synonyms.**—Medicinal Charcoal, Decolorizing Charcoal; *Fr.* Charbon Medicinale.

**Definition.**—The residue from the destructive distillation of various organic materials, treated to increase its adsorptive power.

**Preparation.**—Activated Charcoal may be prepared from sawdust, cellulose residues, coconut shells, dried blood, and other substances by carbonization. The charcoal resulting is then heated to a high temperature in a stream of gases containing activating substances, and subsequently purified by first washing with acids and then with water, afterwards drying. It may also be prepared

by first mixing it with pumice before charring or by using zinc chloride before charring and charring it at a low temperature.

**Description.**—A fine, black, odorless, and tasteless powder free from gritty matter.

**Uses.**—In medicine, as an absorbent and an antidote for poisoning by mercuric chloride, poisonous mushrooms, strychnine, morphine and other alkaloids; as a decolorizer and purifying agent in chemical and pharmaceutical processes, and for the adsorption of gases.

**Average Dose** (unof.).—1 Gm. (15 grains).

#### MYRICACEÆ (WAX MYRTLE AND BAYBERRY FAMILY)

Diœcious or sometimes monœcious, aromatic shrubs or trees with watery juice and possessing underground branches which arch downward, then upward producing many suckers. Roots fibrous and bearing many short rootlets upon which are frequently found coralloid clusters of tubercles containing the *Actinomyces Myricarum* Youngken. Leaves alternate, revolute in vernation, serrate, irregularly dentate, lobed or entire, rarely pinnatifid, pinnately and reticulately veined, pellucid-punctate, evergreen (*Myrica cerifera*) or deciduous (*Myrica pensylvanica*, *Comptonia*), generally exstipulate, rarely stipulate. Flowers naked, unisexual, monœcious or diœcious, in the axils of unisexual or androgynous aments from scaly buds formed in the summer in the axils of the leaves of the year, remaining covered during the winter and opening in March or April, before or with the unfolding of the leaves of the year.

Fruit an akene (*Comptonia*) or ceriferous nut (*Myrica*). Pericarp covered with glandular emergences which secrete wax or fleshy emergences, smooth and lustrous or smooth, glandular. Seed erect, exalbuminous, covered with a thin testa. Embryo straight, cotyledons thick, plano-convex; radicle short, superior.

There are two distinct genera of this family, e.g., *Myrica* and *Comptonia*.

Among the outstanding histological characteristics might be mentioned the following: Superficial development of cork, feebly developed wood parenchyma, narrow medullary-rays in wood, broadening out in wedge-shaped fashion in the phloem, a discontinuous to continuous band of sclerenchyma fibers in the pericycle, leaf epidermis showing stomata with 5-10 neighboring cells, unicellular non-glandular hairs and stalked glandular hairs with balloon-, bowl-, or saucer-shaped oil or resin containing heads. Rosette aggregates and monoclinic prisms of calcium oxalate, tannin and gummy lignin occur in the axis of many of the species.

#### MYRICA (BAYBERRY)

**Synonyms.**—Wax Myrtle Bark, Bayberry Bark, Candleberry, Candlewood, Wax Berry, Tallow-shrub, Tallow-Bayberry, Sweet-oak; *Ger.* Wachsmyrte; *Fr.* Arbre à suif.

**Botanical Origin.**—*Myrica cerifera* Linné and *Myrica pensylvanica* Loiseleur-Deslongchamps (*M. carolinensis* Miller).

**Part Used.**—The dried bark of the root.

**Habitat.**—*M. cerifera* or Wax Myrtle is indigenous to brackish marshes, sandy soil on the border of brackish ponds, estuaries and near the sea, from as far north as the Tuckahoe River, N. J., through southern Jersey, Maryland, Virginia, as far south as Southern Florida, west through the Gulf States to the shores of Arkansas Bay in Texas and northward in the region of the Mississippi to the valley of the Washita River in Arkansas. *Myrica pensylvanica* (*M.*



FIG. 109.—*Myrica cerifera* (Wax Myrtle). Fructiferous branches, showing evergreen leaves which persist over the winter. The ceriferous nuts of this and allied species are employed in the manufacture of the fragrant "Bayberry" candles.

*carolinensis*) or Bayberry is found chiefly near the coast but also in inland swamps and pine forests from Nova Scotia to Florida and Louisiana, on the borders of the Great Lakes and in Indiana.

**Plants.**—*Myrica cerifera* is an evergreen dioecious shrub or tree from 1 to 12 m. high, erect to ascending in habit with a tall crooked trunk and upright or spreading crooked branches which form a round-topped head. The leaves are coriaceous, simple, alternate, exstipulate, lanceolate or oblong-lanceolate,

pinnate-reticulate in venation, acute, mucronate, obtuse or notched at apex, long cuneiform at base and decurrent on the short stout petiole, glandular-punctate with orange-red sunken and golden yellow raised glandular hairs on both surfaces and shining dark green on upper surface. The inflorescences are male and female catkins on separate plants, partly formed the year before flowering below the leaves on the previous season's wood. The fruits are small, spherical, bluish-white, ceriferous nuts, the pericarp of which is covered with glandular emergences which secrete wax. They are employed in the manufacture of the fragrant Bayberry candles. The seed is erect and exalbuminous.

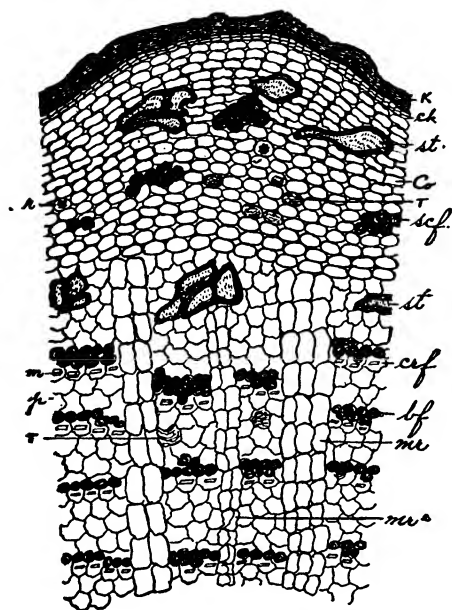


FIG. 110.—Transverse section of the root bark of *Myrica cerifera*,  $\times 75$ . K, cork; ck, cork cambium; co, cortex; T, tannin cells; st, stone cells; scf, sclerenchyma fibers; r, rosette crystals of calcium oxalate; m, monoclinic prisms of calcium oxalate; p, phloem; bf, bast fibers; mr, primary medullary ray; mr<sup>2</sup>, secondary medullary ray; crf, crystal fibers. (After Youngken in Jour. A. Ph. A., p. 485, 1923.)

*Myrica pensylvanica* is a deciduous shrub attaining a height of 2 to 3 m. with elliptic-obovate, membranous leaves which, while bearing golden yellow, balloon-shaped, glandular hairs, are devoid of the orange-red depressed, bowl- and saucer-shaped glandular hairs which are found along with the former type on *M. cerifera* and hybrids between *M. cerifera* and *M. carolinensis* (*M. Macfarlanei* Youngken).

**Production and Commerce.**—The drug is chiefly collected from plants growing wild in the states bordering the south Atlantic seaboard. The root bark of *Myrica cerifera* is the chief kind of bark gathered.

#### Description of *M. Cerifera* Bark.

In strips, quills or transversely curved pieces of varying length and breadth and usually 2.5 mm. or less in thickness, rarely up to 5 mm. in thickness (aerial stem bark); outer surface either silvery-gray, reddish-brown or grayish-brown, scaly in rhizome and root barks, bearing occasional warts or slight transverse ridges, that of the aerial stem bark exhibiting a number of raised oval lenticels; inner surface deep rusty brown to brown, finely longitudinally striated, somewhat roughened (rhizome and root barks); fracture short, weak and uneven; fractured surface brown with short projecting fibers near or along inner border of root bark; odor characteristic; taste astringent, mildly bitter and slightly acrid.

**Histology of Root Bark (*M. cerifera*).**—1. *Cork* of several layers of irregular brick-shaped cells which vary in their staining capacity. Many of the cells have highly suberized walls which stain green with extract of chlorophyll. Some,

however, have all of their walls lignified, while others show lignification only on their inner walls.

2. *Phellogen* of meristematic cells, usually collapsed.

3. *Secondary cortex* whose cells are tangentially elongate and smallest in the outermost portion, becoming larger as one passes toward the phloem. Usually 3 or 4 of the outer layers of the exocortex region are devoid of intercellular-air-spaces. The remaining layers show numerous air-spaces which are for the greater part small and angular. Most of the cortical parenchyma cells contain starch grains with a central, cleft hilum, the grains either simple and spheroidal or 2-4-compound, the individual grains up to  $12\mu$  in diameter. Some, however, contain rosette aggregates and monoclinic prisms of calcium oxalate, while others have their walls thickened and are filled with a yellowish-brown substance which presents the following reactions: It is insoluble in cold or boiling water, cold concentrated potash solution, ammonia, alcohol or xylol. It is soluble in boiling nitric acid, boiling concentrated potash solution and hot solution of sodium hypochlorite. This substance has been termed "lignine-gommeuse" (gummy lignin) by Tison and Chevalier.

The rosette aggregates are from 11 to  $45\mu$  in diameter.

Sclerenchyma fibers which are quite narrow are few and usually isolated singly or in small groups of 2, 3 or rarely 4 amongst the cells of the cortex. Stone cells occur singly or in groups within this region.

4. *Endodermis* whose cells do not differ materially from those of the adjacent cortex.

5. *Phloem*, a comparatively broad zone of irregular phloem patches and medullary-rays, the latter often broadening out toward the cortex in fan-shaped fashion. The primary medullary rays are mostly 1 to 4 cells, rarely 1-5 cells broad. The secondary medullary rays are 1 to 2 cells broad. The bast fibers are arranged singly or in groups forming interrupted circles. They are more numerous in the secondary phloem than in the protophloem region. Crystal fibers containing monoclinic prisms of calcium oxalate accompany the bast fibers. Stone cells occur in both this region and the cortex and are arranged both singly or in groups. They are of variable shape, have lamellated, porous, lignified walls and vary in length from  $24\mu$  to  $129\mu$  and in breadth from 15 to  $59\mu$ . Starch grains and tannin are found both in the phloem cells and the phloem medullary-rays. Many of the phloem cells and air spaces contain monoclinic prisms of calcium oxalate 7 to  $22\mu$  in length. Frequently several crystals are present in one cell or space.

**Histology of Rhizome Bark (*M. cerifera*).**—The bark of the rhizome of *Myrica cerifera* differs histologically from the aerial stem and root barks in the following particulars: In transverse section the cortex cells appear more rounded, less tangentially-elongate. The intercellular-air-spaces are somewhat larger. No crystals of calcium oxalate have been found in the cortex. There are generally more cells containing gummy lignin. Sclerenchyma elements are entirely wanting in the cortex. A discontinuous zone of sclerenchyma is present in the pericycle composed of numerous widely separated small islets of comparatively



thin-walled pericyclic fibers. The phloem region averagely shows fewer bast fibers. The medullary-rays cells are broader and have thinner walls.

**Powdered Drug.**—Reddish-brown; numerous crystals of calcium oxalate in monoclinic prisms up to  $25\mu$  in length, or in rosette aggregates up to  $35\mu$ , rarely  $45\mu$  in diameter; numerous simple, or 2- to 3- or rarely 4-compound starch grains, the individual grains being spheroidal or plano-convex, often with a central cleft and up to  $12\mu$  in diameter; strongly lignified, porous sclerenchyma fibers

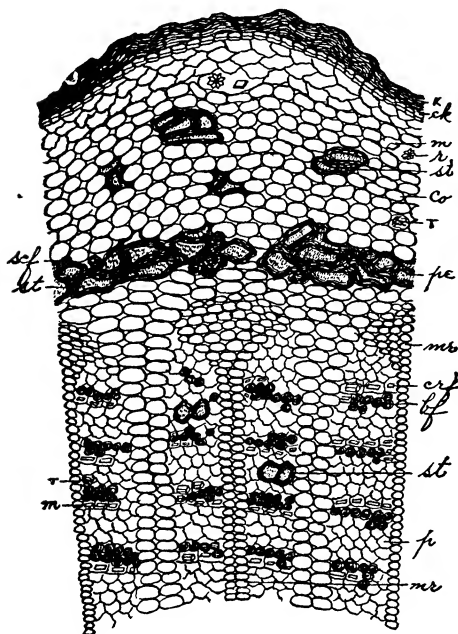


FIG. 111.

FIG. 111.—Transverse section of the aerial stem bark of *Myrica cerifera*,  $\times 75$ . K, cork; ck, cork cambium; co, cortex; pe, pericycle, containing a nearly continuous band of stone cells and sclerenchyma fibers (scf), the stone cells predominating; p, phloem; bf, bast fibers; crf, crystal fibers; T, tannin cells; mr, medullary rays; r, rosette crystals and m, monoclinic prisms of calcium oxalate. (After Youngken in Jour. A. Ph. A., p. 485, 1923.)

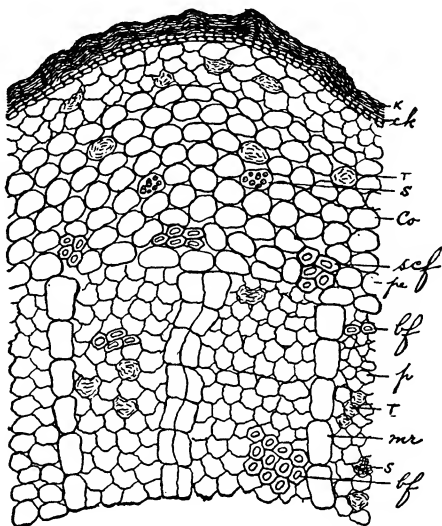


FIG. 112.

FIG. 112.—Transverse section of rhizome bark of *Myrica cerifera*,  $\times 75$ . K, cork; ck, cork cambium; co, cortex; pe, pericycle, containing islets of sclerenchyma fibers (scf); p, phloem, separated into phloem patches by medullary-rays (mr); bf, bast fibers in phloem patches; s, starch; T, tannin. (After Youngken in Jour. A. Ph. A., p. 486, 1923.)

with walls up to about  $13\mu$  in thickness, often accompanied by crystal fibers containing monoclinic prisms; rounded or irregular stone cells up to  $125\mu$  in length, usually in groups, with thick, lignified, lamellated, porous walls; cork cells polygonal in surface view, some with brownish walls and filled with reddish contents; fragments of parenchyma, some of the cells rich in starch; cells containing gummy lignin; tracheæ with bordered pores from adhering wood very few or absent.

**Constituents.**—*Tannin* (giving a bluish-black precipitate with ferric chloride T.S.), an *acrid resin* soluble in alcohol and ether, an *astringent resin* soluble

in alcohol and insoluble in ether, *volatile oil*, *myricinic acid*, gummy-lignin, gallic acid, starch, calcium oxalate, red coloring matter, etc.

**Uses.**—Astringent and tonic, stimulant to indolent ulcers, and as an ingredient in unofficial Composition Powder.

**Average Dose.**—0.5 Gm. (8 grains).

**Comptonia** or Sweet Fern consists of the dried leaves of *Comptonia peregrina* (L.) Coulter, a low, aromatic shrub indigenous to eastern North America. The leaves are petiolate, lanceolate to elliptic-ovate, pinnatifid, showing 4 to 15 pairs of subreniform lobes separated from each other by a sinus extending almost to the midrib; both surfaces showing shining, yellow glands; odor agreeably aromatic; taste bitter, aromatic.

**Constituents.**—About 0.2 per cent. of *volatile oil* containing terpenes and considerable *cineol*; *tannin*, etc. Stimulant and astringent.

#### JUGLANDACEÆ (WALNUT FAMILY)

Walnuts, Hickories, Pecan, Butternut, etc. Trees, often aromatic and resinous with dark-colored durable wood; leaves alternate, imparipinnate, exstipulate; flowers monoecious, the staminate in pendulous catkin-like spikes, the pistillate in erect spikes; ovary inferior, 1-celled; ovule 1, orthotropous; fruit a drupe or nut, often adnate to the matured bracts or bracteoles with succulent mesocarp and hard, bony endocarp; seed exalbuminous, often with contorted cotyledons. The plants are characterized histologically by having peltate glandular hairs and simple hairs which frequently occur in tufts. Calcium oxalate is found in the forms of rosette aggregates or solitary crystals. The cortex shows either isolated groups of sclerenchyma fibers in the pericycle, as in *Carya*, etc., or a composite sclerenchymatous ring (in *Juglans*). The wood shows narrow medullary-rays, simple perforations in the vessels and abundant wood parenchyma. The leaf stomata are surrounded by ordinary epidermal cells.

#### JUGLANS (JUGLANS)

**Synonyms.**—Butternut Bark, White Walnut; *Ger.* Graue Wallnussrinde; *Fr.* Ecorce de Noyer, Noyer Gris.

**Botanical Origin.**—*Juglans cinerea* Linné.

**Part Used.**—Dried inner bark of the root.

**Habitat.**—Eastern United States in rich woods from New Brunswick and Quebec to Georgia, west to Minnesota, Kansas and Arkansas.

**Plant.**—A forest tree with short trunk and broad, deep, round-topped, open crown. The bark varies from nearly smooth, light gray on the branches and young trunk to roughened by black fissures separating broad light gray ridges on older trunks. The wood is light brown, soft and coarse grained. The leaves are alternate, imparipinnate, with 11–17 ovate-lanceolate, serrate leaflets that are glabrous above and pubescent beneath. The fruit consists of an elongated-ovate drupe containing a 4-ribbed nut pointed at one end. The kernel is sweet, oily and edible.

**Production and Commerce.**—The inner bark is separated from the roots, after they have been collected in autumn, and dried. When first uncovered this bark is white but gradually changes on exposure to a lemon color, then to dark brown. The commercial supply comes chiefly from North Carolina, Virginia and Michigan.

**Description.**—It occurs in quills, curved pieces or in chips of variable length and up to 10 mm. thick. The color is deep brown throughout. The outer surface is smooth or warty; the inner surface, smooth and striate, with stringy fibers adhering. The fracture is short and fibrous. The odor is faintly aromatic. The taste is bitter, astringent and acrid.

**Constituents.**—A yellow crystalline acrid substance, a volatilizable acid called juglandic acid (Thiebaud 1872) which appears to be identical with *juglone* (a naphthoquinone occurring in brownish red crystalline needles), oily extractive, gum, resin, etc.

**Use.**—Mild cathartic in habitual constipation.

**Average Dose.**—4 Gm. (60 grains).

#### BETULACEÆ (BIRCH FAMILY)

A family of monœcious rarely dioecious shrubs and trees including the alders (*Alnus*), birches (*Betula*), hornbeam or ironwood (*Carpinus*) and hazelnuts (*Corylus*). The leaves are alternate, simple, pinnately veined with deciduous stipules. The flowers occur in catkins, the female with a 2-celled ovary with 2 pendulous ovules in each cell and 2 styles. The fruit is a one celled, one seeded nut often surrounded by a foliaceous involucre, as in the hazelnuts, or a strobile of nuts, as in the birches.

#### OIL OF SWEET BIRCH (OLEUM BETULÆ)

**Synonyms.**—Black Birch Oil, Oil of *Betula*, Methyl Salicylate; *Ger.* Birkenrindenöl; *Fr.* Essence de *Betula*.

**Botanical Origin.**—*Betula lenta* Linné.

**Part Used.**—A volatile oil distilled from the bark and young twigs.

**Standard.**—It contains not less than 98 per cent. of  $C_6H_4(OH)CO_2CH_3$ .

**Habitat.**—Eastern North America, on dry slopes and in rocky mountain forests.

**Plant.**—The black birch is a tree with black to reddish-brown bark, green and hairy to reddish-brown, smooth twigs covered by horizontally elongated lenticels, ovate, acuminate, serrate leaves, and sharp pointed, conical, shining, alternate buds. The fruit is a strobile with smooth, 3-lobed scales and winged nutlets. The bark does not separate into layers like the paper, red, yellow and gray birches.

**Production and Commerce.**—Most of the oil of sweet birch is now being produced in Connecticut and Tennessee. The bark and twigs are gathered from the trees from May to late September, chopped or ground and placed in retorts with water which are kept warm overnight by a low fire beneath them. The following day the oil is distilled. The yield from a ton of material is about

5 pounds. Methyl salicylate, the active principle constituting oil of sweet birch, does not preexist in the plant. It is formed by the action of the enzyme gaultherase upon the glucoside gaultherin in the presence of water.

**Description.**—A colorless, yellowish or reddish liquid having the odor and taste of wintergreen, optically inactive.

**Uses.**—Antirheumatic and flavoring agent.

#### RECTIFIED BIRCH TAR OIL N.F. (OLEUM BETULÆ EMPYREUMATICUM RECTIFICATUM)

**Synonyms.**—*Oleum Rusci*, Oleum Betulinum; *Ger.* Birkenöl.

**Botanical Origin.**—*Betula pendula* Roth and related species of *Betula*.

**Part Used.**—The pyroligneous oil obtained by the dry distillation of the bark and wood and rectified by steam distillation.

**Habitat.**—Europe and Asia. Naturalized in northern North America.

**Plants.**—The plants yielding the drug are the White Birches chiefly *Betula pendula*, *B. alba* and certain of their varieties. They are medium sized trees having white bark which separates in layers and shows numerous lenticels, and ovate, doubly-serrate leaves which are slightly hairy and glandular-dotted on the veins beneath.

**Commercial Source.**—Russia.

**Description.**—A clear, dark brown liquid having a penetrating empyreumatic odor resembling that of Russia leather.

**Constituents.**—*Cresol*, *creosote*, *guaiacol*, *pyrobetulin*, an antiseptic principle; xylol, traces of *phenols*, etc.

**Storage.**—It should be preserved in tight, non-metallic containers, protected from light.

**Uses.**—Applied locally in solutions or ointments as a parasiticide and antiseptic in the treatment of eczema and other skin diseases. A constituent of compound resorcin ointment.

**Preparation.**—Compound Resorcinol Ointment, N.F.

#### FAGACEÆ (BEECH FAMILY) (CUPULIFERÆ)

**Beeches, Chestnuts, Oaks.**—The trees of this family are found in the temperate forests of the eastern and western hemispheres and comprise about 368 species. North America has over 50 species of oaks; 2 species of chestnuts; 1 species of beech and 1 species of golden-leaved chestnut. The most important American oaks used for building, for furniture, for cooperage, for wagons, for tanning leather, etc., are white oak, *Quercus alba*; chestnut oak, *Q. montana*; black oak, *Q. velutina*; live oak, *Q. virginiana*; swamp white oak, *Q. platanooides*; cow oak, *Q. Michauxii*, and the two Pacific coast oaks, *Q. chrysolepis* and post oak, *Q. garryana*. The uses of the fast disappearing chestnut, *Castanea dentata*, are well known. The wood of the beech, *Fagus grandifolia*, is used for chairs, tool handles, plane stocks, shoe lasts and for fuel. The nuts (mast) fatten hogs and feed wild animals and birds. The cork of commerce is obtained from the

bark of *Quercus Suber* and *Quercus occidentalis*, plants indigenous to Spain and France.

The above trees are all monœcious, that is, the staminate (male) and pistillate (female) flowers are distinct from each other, but borne on the same tree. Most of the species are trees, a few oaks are shrubs. The leaves are simple, netted-veined and alternate. A pair of deciduous stipules are found at the base of the leaf-stalk (petiole). The margins of the chestnut and beech leaves are sharply cut with large teeth. The leaves of the oaks divide the genus into two groups, viz.—the white oaks with rounded lobed leaves and annual acorn production, and the black oaks with sharp bristle-tipped lobes and biennial acorn production. The male flowers are in dangling heads (beech), or in catkins (chestnut and oaks). The male flowers have a united perianth, which is 4–6 parted and encloses an indefinite number of undivided stamens. The female flowers have a superior 6-parted perianth, the pistil consisting of 3 carpels with a corresponding number of stigmas. The ovary is 3–6-celled and each cell has 2 pendulous ovules. The fruit is a one-seeded nut. The cup, or cupule, in the beech is 4-sided, is covered externally with weak spines and encloses two 3-sided seeds. The cupule in the chestnut forms the spiny bur, which splits into 4 valves at maturity, enclosing 3 nuts. The cupule in the oak is saucer-, or cup-shaped, and encloses a single rounded nut, or acorn. The seeds are exalbuminous and the cotyledons are thick and fleshy, edible in the beech, chestnut and a few of the oaks.

The principal histological peculiarities of this family are as follows: Subepidermal cork development; wood fibers with bordered pits; a sclerenchyma ring in the pericycle; non-glandular hairs unicellular or uniseriate or tufted; glandular hairs of varying shape; stomata devoid of neighboring cells; calcium oxalate in rosette aggregates, often in crystal fibers, or as solitary crystals; numerous tannin cells; tracheæ with scalariform markings numerous.

#### NUTGALL N.F. (GALLA)

**Synonyms.**—Galls, Aleppo Galls, Smyrna Galls; Turkey or Syrian Galls; *Ger.* Galläpfel; *Fr.* Galla d'Alep.

**Botanical Origin.**—*Quercus infectoria* Olivier (*Quercus lusitanica* Lam.) and other allied species of *Quercus*.

**Part Used.**—The excrescence obtained from the young twigs.

**Habitat.**—Mediterranean Basin from Greece to Persia.

**Production and Commerce.**—The female of *Cynips tinctoria*, gall-fly, (Class *Insecta*, order *Hymenoptera*, family *Cynipidæ*) punctures the young leaf buds of the dyer's oak with her ovipositor and deposits one or more eggs in the wound. The egg hatches and a young insect or larva emerges in the plant tissue. The larva secretes a fluid (probably from its salivary glands) which contains an enzyme capable of converting starch into sugar. The cells immediately surrounding the larva contain considerable starch and are termed the nutritive zone. This starch is gradually changed to sugar by the enzyme which makes more food available than usual to the growing plant cells. The protoplasm of

these is, accordingly, stimulated toward greater cell-reproduction as the rate of change from starch to sugar is accelerated, and a hypertrophied growth, tumor or gall is the result. In the gall the insect undergoes a metamorphosis, passing from the larva or "worm" stage to the chrysalis or pupa stage and thence to the imago or adult stage. In this last stage it channels its way out leaving a tubular canal communicating with a central hollow cavity. While the insect

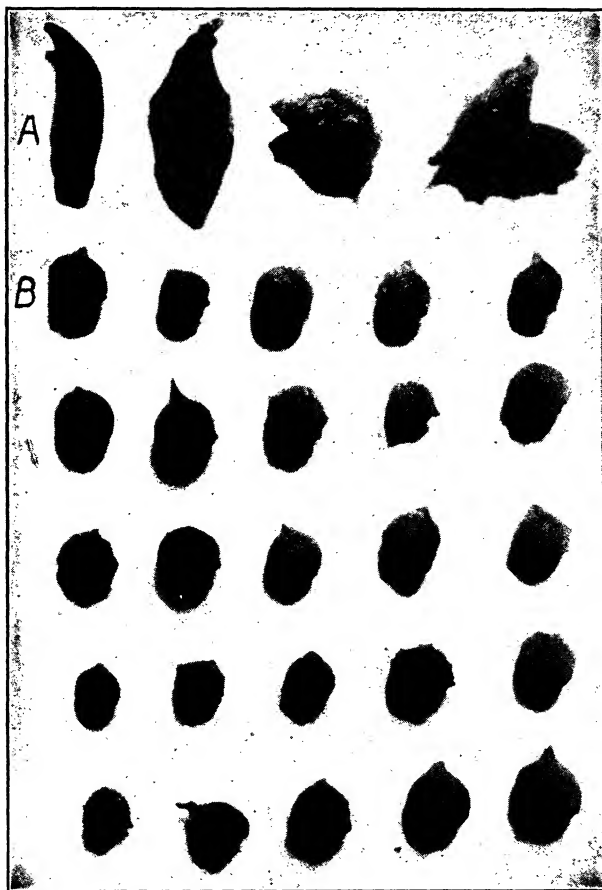


FIG. 113.—Chinese galls (A); Aleppo galls (B).

is in the early larval stage most of the cells of the gall contain numerous tiny starch grains. By the time the larva is transformed to a chrysalis, gallic acid has taken the place of considerable of the starch in the cells near the middle of the gall, while tannic acid in masses is abundantly present in the cells at the center and near the outer margin. When the imago or adult winged insect is developed, most of the cells of the gall contain masses of tannin together with a small amount of gallic acid. After the imago has emerged from the gall, the tannin constituent of the cells undergoes oxidation which results in replacement by an

insoluble product. The gall becomes lighter in weight and color and more spongy in texture. The so-called "White Galls" of commerce represent this last stage.

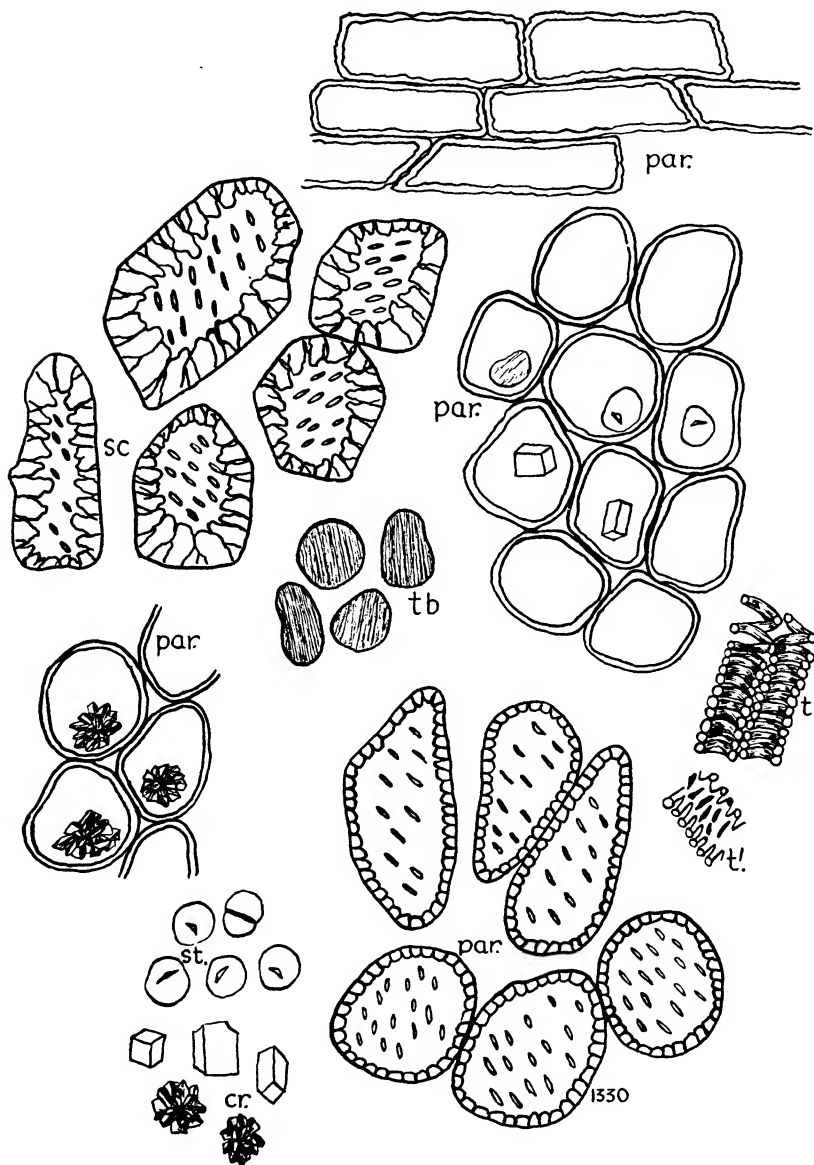


FIG. 114.—Powdered Nutgall. *par.*, parenchyma; *sc*, stone cells; *tb*, tannin bodies; *st.*, starch grains; *cr.*, rosette aggregates of calcium oxalate; *t*, spiral tracheae; *t'*, reticulate tracheae; *par* (below), thick-walled, pitted parenchyma. (Drawn by J. Izzo.)

The galls should be collected before the insect has emerged. Most of the official galls are gathered by the peasants of Asia Minor, Syria and Persia who dry them in the sun. During this time they lose about 50 per cent. in weight.

The product is then sold to dealers in small villages or bartered for articles of European manufacture. On account of different stages of maturity, the galls vary in color from black, through green and blue, to white. The black galls contain the most tannin, the white the least. The galls are graded by the exporter according to color into blue, green and white. Aleppo Nutgalls are exported to this country from Syria, Iraq, Turkey and from Italy. During 1947, 2,000,307 lbs. of nutgalls were imported into this country from Turkey, Syria, China and Hong Kong.

**Description.**—Nearly globular, from 0.8 to 2.5 cm. in diameter; externally moderate brown to weak olive, more or less tuberculated on upper portion, the basal portion nearly smooth and contracted into a short stalk; heavy, sinking in water, excepting smaller galls; breakable and short horny; internally light yellowish-brown to weak yellowish-orange, consisting of a central slightly radiating and resinous portion, occasionally hollow and traversed by a narrow radial canal extending to the exterior as shown by the hole in the whole gall; odor slight; taste strongly astringent.

**Powdered Drug.**—Weak yellow; numerous fragments of thick-walled starch parenchyma; numerous simple, spheroidal, ellipsoidal or polygonal starch grains up to  $30\mu$  in diameter or length, and compound grains; few stone cells with thick lignified walls and branching pore canals; a few spiral and reticulate tracheæ; oval or bean-shaped tannin masses; monoclinic prisms and rosettes of calcium oxalate, the latter up to  $40\mu$  in diameter.

**Constituents.**—*Tannic acid* U.S.P. (50 to 70 per cent.), *gallic acid* (2 to 4 per cent.) resin, calcium oxalate and starch.

**Uses.**—Astringent, chiefly in the form of the ointment. Nutgall is the chief source of tannic acid. Tannic acid has astringent and styptic properties and is a chemical antidote for poisoning by alkaloids.

**Average Dose** of nutgall and tannin.—0.5 Gm. (8 grains.)

**Preparation of Nutgall.**—Nutmall Ointment, N.F.

**Adulterants.**—The whole drug frequently is admixed with White Galls. The powdered drug has been admixed with ground nut shells and olive pits.

**Allied Drug.**—**Chinese Galls** are produced on the leaves of *Rhus chinensis* Miller (*R. semialata* Murray) by the sting and deposited ova of an *Aphis* (plant louse). They are quite irregular in shape, irregularly lobed with a number of protuberances and have a thin wall and large hollow interior. They contain 70 to 80 per cent. of tannin. The powdered drug is grayish-green to brownish ash gray and shows under the microscope numerous unicellular trichomes with pointed ends that are frequently recurved, greenish-yellow resin masses, fragments of thin-walled parenchyma, spheroidal starch grains, up to  $40\mu$  in diameter and rosette aggregates of calcium oxalate up to  $25\mu$  in diameter. More than 2,000,000 pounds of Chinese Nutgalls have been imported annually into this country from China.

**Tannic Acid (Acidum Tannicum)** U.S.P., also known as *Gallotannic Acid* and *Tannin*, is a tannin usually obtained from nutgalls, the excrescences obtained from the young twigs of *Quercus infectoria* and other allied species of *Quercus*



(Fam. *Fagaceæ*). It occurs as a yellowish white to light brown powder, as glistening scales or spongy masses. It is odorless, astringent to the taste and very soluble in alcohol and water. 1 Gm. dissolves in about 1 cc. of warm glycerin. Astringent; antidote for poisoning by alkaloids, and in aqueous solution or jelly in the treatment of burns. Dose as antidote, 15 grains. U.S.P. Preparations: Tannic Acid Glycerite, Tannic Acid Ointment.

### QUERCUS (QUERCUS)

**Synonyms.**—White Oak Bark; *Fr.* Ecorce de chêne; *Ger.* Eichenrinde.

**Botanical Origin.**—*Quercus alba* Linné.

**Part Used.**—The dried inner bark of the trunk and branches.

**Purity Rubric.**—Not more than 2 per cent. of its outer bark or wood or other foreign organic matter. N.F. V.

**Habitat.**—United States from Maine to Minnesota, south to Florida and Texas.

**Plant.**—A large tree with an average height of 70 to 80 feet which, when grown in the open, has a crown of gnarled and twisted, lateral, leafy branches. Its leaves are alternate, obovate with 3- to 9- but usually 7-ascending, rounded lobes, which are separated by deep round-based sinuses. The yellow staminate flowers open in May when the leaves are partly developed and are found on hairy aments. The pistillate flowers occur on short axillary stalks with hairy, involucre scales and possess red spreading styles. The fruit is an acorn with ovoid, shining glans, and bowl-shaped cupule.

**Commercial.**—The commercial supplies of oak bark come chiefly from Michigan and Germany. The imported article usually comes in the form of the cut and sifted drug and is shipped in bags.

**Description.**—In nearly flat pieces up to 10 mm. in thickness; externally light brown, darkening with age, rough splintery; fracture uneven and coarsely fibrous; odor faint; taste strongly astringent, not tingeing the saliva yellow when chewed.

**Powdered Drug.**—Light brown. Numerous thick-walled, lignified sclerenchyma fibers; numerous crystal fibers containing prismatic crystals or rosette aggregates of calcium oxalate; stone cells with thick, lamellated walls, up to  $100\mu$  in length; starch grains up to  $10\mu$  in diameter; fragments of parenchyma with yellowish-brown amorphous contents; few fragments of cork with brownish amorphous content.

**Constituents.**—*Quercitannic acid* (about 10 per cent.), oak red, quercetin, pectin, resin, calcium oxalate, etc.

**Use.**—Astringent. Chiefly used in the tanning industry.

**Average Dose.**—1 Gm. (15 grains).

**Adulterant.**—The bark of the Black Oak, *Quercus velutina* Lam., which is reddish-brown and tinges the saliva yellow on chewing. The yellow coloring principle is quercetin which is derived from the glucoside quercitrin by hydrolysis.

## CASTANEA (CASTANEA)

**Synonyms.**—Chestnut Leaves; *Fr.* Feuilles de chataignier; *Ger.* Kastanien-blätter.

**Botanical Origin.**—*Castanea dentata* (Marshall) Borkhausen.

**Part Used.**—The dried leaf.

**Purity Rubric.**—It contains not more than 5 per cent. of the stems of the plant or of other foreign matter, and yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—North America, from Maine to Michigan, south along the mountain ranges to Alabama, Mississippi and Arkansas.

**Plant.**—A large spreading tree growing to a height of 60 to 100 feet and having a trunk diameter of 3 to 10 feet. The leaves are smooth, simple, alternate, oblong-lanceolate, sharp pointed at apex, and serrate along margin. The staminate flowers are crowded on lower aments. The pistillate flowers appear at the base of the upper aments as globular structures. The fruit is a spiny bur containing from 1 to 5, usually 2 or 3, nuts.

**Collection.**—The leaves are gathered in autumn and carefully dried.

**Description.**—Leaves usually folded and matted together or broken; when spread out and entire, petiole about 12 mm. in length; lamina oblong-lanceolate; up to about 25 cm. in length and about 5 cm. in breadth; sharp attenuate-pointed at apex, acute at base, coarsely serrate along margin, the teeth being attenuated; nearly smooth; coriaceous; upper surface olive to weak olive green; lower surface paler green; pinnately veined, the veins of the first order diverging at an angle of about 60°, each terminating in one of the teeth; odor slight; taste astringent.

**Constituents.**—About 9 per cent. of a *tannin* which is colored green to greenish black with solutions of iron salts; mucilage, resin, etc.

**Use.**—Astringent and tonic.

**Average Dose.**—4 Gm. (60 grains).

**Preparation.**—Fluidextractum Castaneæ N.F. VII, 4 cc. (1 fl. dr.).

## CREOSOTUM N.F. (CREOSOTE)

**Synonyms.**—*Creasote*, *Wood Creasote*; *Fr.* Creosote; *Ger.* Kreosot.

**Definition.**—A mixture of phenols obtained from wood tar.

**Description.**—An almost colorless or yellowish, highly refractile oleaginous liquid having a penetrating, smoky odor and a burning, caustic taste. It burns

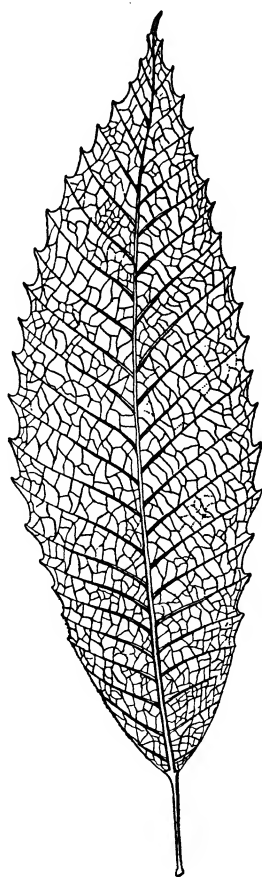


FIG. 115.—Chestnut leaf.  
(After Sayre.)

with a luminous smoky flame. It is slightly soluble in water, but miscible with alcohol and fixed and volatile oils.

**Identity Test.**—To 10 cc. of a saturated aqueous solution, add 1 drop of ferric chloride T.S. A transient purple color develops, followed by cloudiness, the color changing from blue through green, a brown precipitate finally forming.

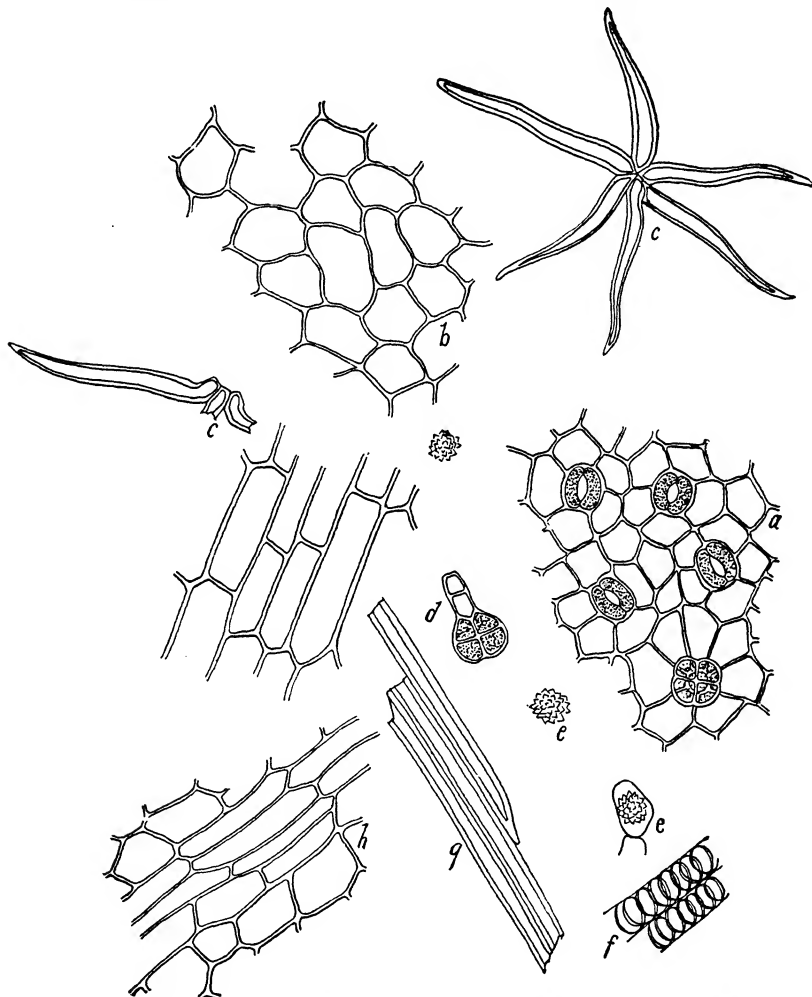


FIG. 116.—*Castanea*. Leaf elements. (a) Lower epidermis; (b) upper epidermis; (c) stellate trichomes; (d) glandular trichome; (e) rosette crystals; (f) spiral ducts; (g) sclerenchyma fibers; (h) parenchyma. (Schneider.)

**Production.**—While creosote can be made from wood-tar which is yielded by the process of destructive distillation applied to any wood, the most valued creosote is that produced by the fractional distillation of the wood tar of beeches (*Fagus* spp.) and known as beechwood creosote.

**Adulterants.**—Rectified oil of tar, phenol, fixed and volatile oils.

**Constituents.**—The phenols guaiacol, cresol, methyl-cresol and phlorol, etc.

**Uses.**—Antiseptic, disinfectant, expectorant. Internally as an expectorant in bronchitis and pulmonary tuberculosis and as a gastro-intestinal antiseptic; local anesthetic in dentistry.

**Average Dose.**—0.25 cc. (4 minims).

**Allied Drugs.**—**Creosote Carbonate** (**Creosoti Carbonas**) N.F. is a mixture of the carbonates of various constituents of creosote. It is a clear, colorless or yellowish, odorless and tasteless or with a slight creosote odor and taste. Expectorant in bronchitis and phthisis. Av. dose, 1 Gm. (15 grains).

**Guaiacol N.F.** is a liquid consisting principally of  $C_6H_4(OH)(OCH_3)$  1:2, usually obtained from wood creosote, or a solid, consisting almost entirely of  $C_6H_4(OH)(OCH_3)$  1:2, usually prepared synthetically. Expectorant. Av. dose, 0.5 cc. (8 minims).

**Guaiacolis Carbonas** (Guaiacol Carbonate) or Duotal occurs as colorless crystals or in a white crystalline powder insoluble in water. It is prepared from guaiacol. Expectorant. Av. dose, 1 Gm. (15 grains).

#### ULMACEÆ (ELM FAMILY)

Forest trees indigenous to the temperate and tropical zones, characterized by being woody plants, with alternate simple, often unequal sided pinnately veined leaves and caducous stipules and without milky juice. Their flowers are unisexual or hermaphroditic with 8 or 4 parts to the calyx; stamens inserted at base of calyx; pistil of 2 connate carpels with a 1- to 2-celled ovary and 2 styles bearing stigmatic surfaces on their inner face. Fruit a single samara. Seed devoid of endosperm.

#### ELM N.F. (ULMUS)

**Synonyms.**—*Elm Bark*, *Slippery Elm*; *Fr.* Ecorce d'Orme; *Ger.* Ulmenrinde.

**Botanical Origin.**—*Ulmus fulva* Michaux.

**Part Used.**—The dried inner bark.

**Purity Rubric.**—It contains not more than 2 per cent. of adhering outer bark and yields not more than 1 per cent. of acid-insoluble ash.

**Habitat.**—Quebec to North Dakota, south to Florida and Texas.

**Plant.**—A tree attaining a height of 50 to 60 feet and a trunk diameter of 1 to  $2\frac{1}{2}$  feet, with stout ascending branches and broad, flat-topped crown. Its bark is thick, tough, dark brown and longitudinally fissured, the inner bark being fragrant and mucilaginous. Its leaves are alternate, ovate to obovate, dark green, acute at apex, unequal at base, doubly serrate along margin and possess a scabrous surface. The flowers appear before the leaves, in April, clustered on short stalks. The fruit is a short-stalked, flat samara consisting of a central seed surrounded by a yellowish wing.

**Production and Commerce.**—The Slippery Elm trees are found in large numbers in Michigan. The bark is collected in spring, deprived of its cork, sawed into oblong pieces and dried. It is then packed in bundles which are bound at either end with wire. Most of the commercial supply comes from Michigan.

**Description.**—In sawed or cut, broad, flat or oblong pieces from 1 to 4 mm. in thickness, yielding mucilage when moistened; outer surface weak yellowish-orange with occasional dark brown patches of adhering cork, longitudinally striate and with partially detached bundles of bast fibers, colored blackish upon the addition of very dilute iodine test solution; inner surface weak yellowish-orange, nearly smooth and finely longitudinally striate; fracture fibrous with projections of fine bundles of phloem fibers; fractured surface porous; odor distinct; taste mucilaginous.

**Histology.**—Transverse sections show for the most part a broad phloem composed of alternating interrupted bands of bast fiber groups and soft bast.

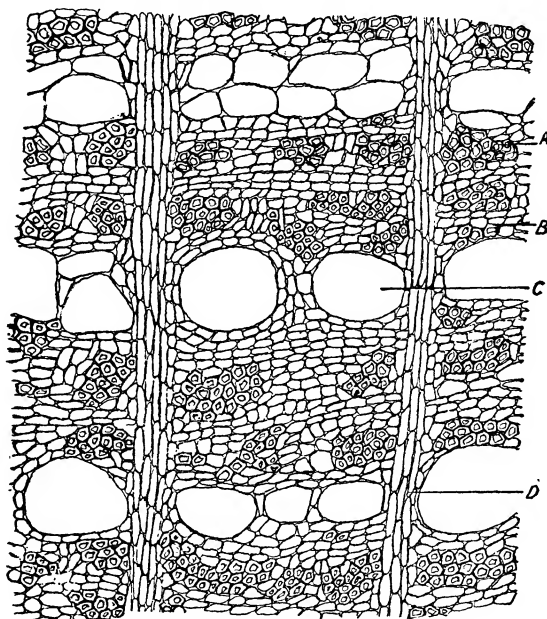


FIG. 117.—*Ulmus*—Cross-section of bark. A, Bast fibers; B, phloem parenchyma; C, mucilage sacs; D, medullary rays. (Sayre.)

Running at right angles to these are starch bearing medullary-rays from 1 to 6 cells in width. The bast fiber groups are surrounded by crystal fibers containing monoclinic prisms or twin crystals of calcium oxalate 10 to  $35\mu$  in length. In each soft bast zone (between 2 medullary-rays) occur rows of mucilage sacs, sieve strands and starch-bearing parenchyma. Many of the medullary-ray cells and phloem parenchyma cells and the majority of cortical parenchyma cells, adhering to phloem, contain small spheroidal to polygonal starch grains from  $3\mu$  to  $25\mu$  in diameter.

**Powdered Drug.**—Weak yellowish-orange. Numerous long, thick-walled, bast fibers, usually broken, up to  $25\mu$  in diameter with non-lignified or only slightly lignified walls; starch grains spheroidal or polygonal, usually from  $3\mu$  to  $15\mu$  in diameter, occasionally up to  $25\mu$ ; monoclinic prisms of calcium oxalate up to  $35\mu$  in length; twin prisms of calcium oxalate; numerous fragments of paren-

chyma with embedded mucilage cells; numerous fragments of mucilage which are frequently lamellated; brown walled cork cells few or absent. Odor distinctive, somewhat resembling powdered foenugreek.

**Constituents.**—*Mucilage*, starch, tannin and calcium oxalate.

**Uses.**—Demulcent and emollient; the powdered drug as a poultice.

**Preparation** (unof.).—Elm Troches (1 troche).

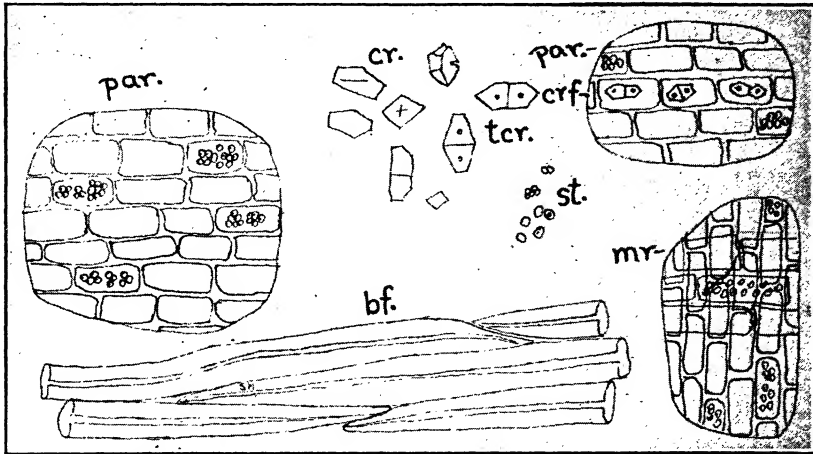


FIG. 118.—Powdered *Ulmus*. *par.*, starch- and crystal-parenchyma; *crf.*, crystal fiber; *cr.*, monoclinic prisms and *tcr.*, twin prisms of calcium oxalate; *st.*, starch grains; *bf.*, bast fibers; *mr.*, medullary ray traversing parenchyma. (Drawing by S. Mushlin.)

#### MORACEÆ (MULBERRY FAMILY)

Herbs, shrubs or trees characterized for the greater part by containing a milky juice. This exists in laticiferous tubes that pervade the entire plant or are limited to the fibrovascular regions, as in several species of *Ficus*. The leaves are alternate, rarely opposite, simple, with serrate margins and caducous stipules. The flowers are small, monoecious or dioecious, solitary or often in heads, disks or hollow receptacles and variously colored. The fruit is either an akene enclosed by the perianth, nut or drupe.

#### CANNABIS (CANNABIS)

**Synonyms.**—*Cannabis Indica*, Guaza, Ganjah, Hashish, Indian Hemp, Marihuana; *Ger.* Hanf; *Fr.* Chanvre.

**Botanical Origin.**—*Cannabis sativa* Linné.

**Parts Used.**—The dried flowering tops of pistillate plants.

**Limit of Impurities.**—10 per cent. of its fruits, large foliage leaves, stems over 3 mm. in diameter, and not more than 2 per cent. of other foreign matter.

**Ash.**—Not more than 5 per cent. acid-insoluble.

**Habitat.**—Asia. Cultivated in the United States, Africa, India, Europe, Mexico, and Brazil.

**Plant.**—A tall, roughish, annual, dioecious herb thriving in waste and cultivated ground. The stem is angular, may attain a height of 4.5 m., and

bears numerous palmately-compound leaves. The leaflets are linear-lanceolate, serrate and 5-7 in number. The flowers are greenish and borne on axillary panicles (staminate) or catkins (pistillate). The ovarian portion of the pistillate flower is one-celled and contains a pendulous ovule that forms with the ovarian wall a small glandular akene, upon maturation.

**Production and Commerce.**—*Cannabis sativa* is grown in temperate countries for its bast fibers which constitute "hemp" and for its fruits known as "hemp seed." It is cultivated extensively in both tropical and temperate countries



FIG. 119.—*Cannabis*—Branch. (Sayre.)

for its tops. Its foliage leaves and young twigs, when dried, constitute the drug known as "*bhang*"; its resin is separately collected by rubbing the flowering tops between the hands, wiping the resinous matter on carpet or cloth from which it is scraped off, and marketed in India under the name of "*churrus*" or "*charas*." Charas is used as an ingredient of smoking mixtures of varied content. The dried flowering tops constitute "*guaza*" or "*ganjah*." Several varieties of *Cannabis* have been found on the market, taking their names from the countries in which the plants were grown. Of these the most important have been the Indian, American and African.

Indian *Cannabis* is obtained from plants grown in various districts of India, chiefly north of Calcutta and east of Bombay. There the plants are cultivated in rows, collection of the drug taking place as soon as the flowering tops of the female plants have assumed a brownish color. These are then cut off,

the fruits shaken out, allowed to wilt and then subjected to the process of rolling and treading, in order to work resinous matter from the stems into the inflorescences. There are two grades of Indian Cannabis—(1) Round and (2) Flat. The round, sometimes called "Bengal ganjah" or "gauza," is prepared near Calcutta by rolling the wilted tops into cylindrical or rounded resinous masses between the hands. This grade is mostly consumed in India and the West Indies. The flat grade, known as "Flat-" or "Bombay guaja," is produced near the town of Ahmednagar, India. It is kneaded by treading into a compressed flattened form. The color is greenish-brown. The commercial supplies of the Indian grown drug are imported into this country in cases from Bombay, India.

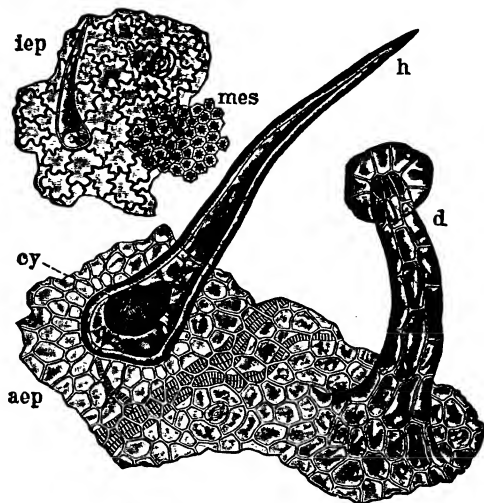


FIG. 120.—Cannabis. Bract in surface view. *aep*, outer epidermis with a glandular hair (*d*) and unicellular, non-glandular hair (*h*), the latter containing a cystolith (*cy*). *iep*, inner epidermis showing wavy-walled epidermal cells and stoma; *mes*, mesophyll, the cells containing small rosette aggregate crystals of calcium oxalate. (After Winton and Winton, "The Structure and Composition of Foods, J. Wiley & Son, Inc.")

**American Cannabis** or *Cannabis Americana*, representing the chief variety used in the United States today, is yielded by *Cannabis sativa* plants cultivated in various sections of the United States. It occurs on the market in the form of broken segments of the inflorescences and more or less crumpled and broken leaves varying in color from green to brownish-green to light brown (in old material). It is less resinous than the Indian variety. The commercial supplies of this variety come from North and South Carolina, Illinois, Indiana, New York, Wisconsin, Kentucky, Texas and Missouri. It is shipped in bags.

**African Cannabis**, from *Cannabis sativa* plants growing near the eastern and western coasts and central regions watered by the Congo and Zambesi rivers, comes into the market in the form of broken leaves and flowering tops of a greenish-brown color which are shipped in bags chiefly from Zanzibar.

**Description.**—In addition to the characteristics previously mentioned for the several commercial varieties, the drug presents the following for examination:



The stems are longitudinally furrowed, not more than 3 mm. in diameter, pubescent and of a weak brown to dusky greenish-yellow color. The short stems (twigs) bear leafy bracts and pistillate flowers, a number of these being replaced by fruits. The foliage leaves are palmately 5-7 compound, the leaflet

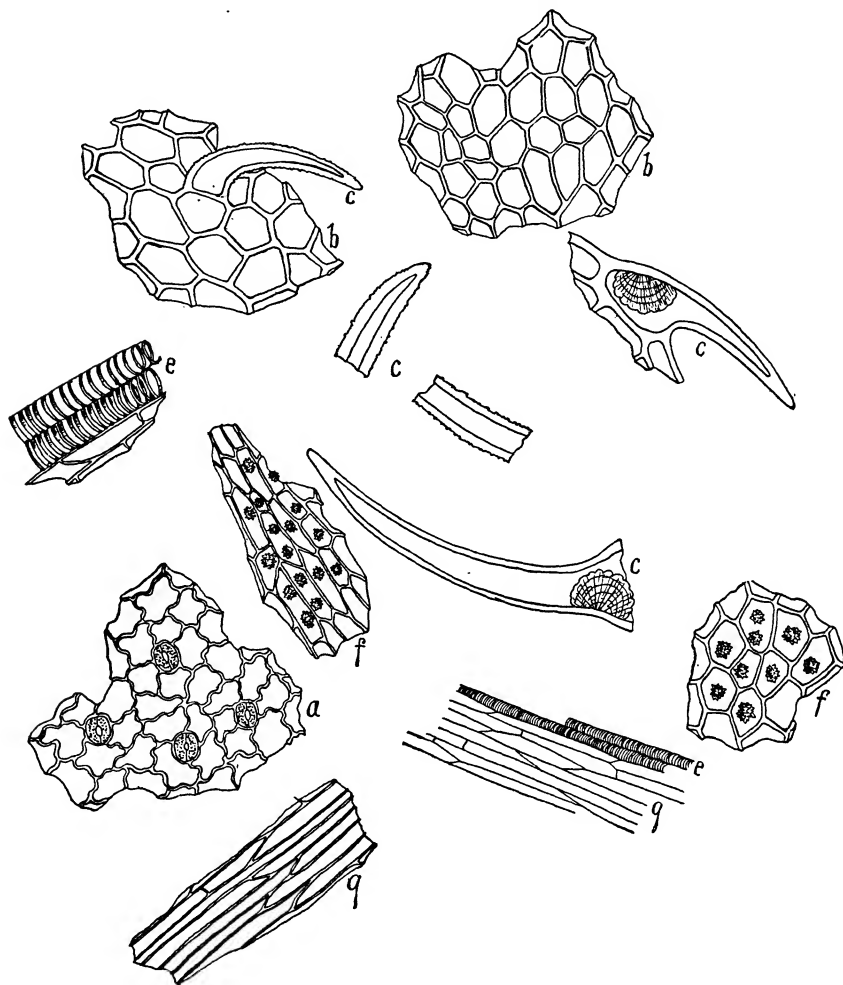


FIG. 121.—Powdered Cannabis. (a) Lower epidermis of leaf; (b) upper epidermis of leaf; (c) trichomes with cystoliths; (e) spiral ducts; (f) parenchyma with minute rosette aggregate crystals; (g) phloem tissue. (After Schneider.)

portions, when soaked in water and spread out, being linear-lanceolate in outline, with acuminate apex and coarsely serrate margin. The bract leaves are ovate-lanceolate, pubescent, each enclosing one or two pistillate flowers, or more or less developed fruits. The calyx is olive green to yellowish-brown, pubescent and somewhat folded around the ovary or fruit. The ovary is one-chambered and contains a single campylotropous ovule. Attached to it are 2 slender, pubescent styles. The fruit is light green to light brown, broadly ellipsoidal,

somewhat flattened, up to 5 mm. long and finely wrinkled or speckled. The odor is agreeably aromatic. The taste is pungent and resinous.

**Histology.**—The compressed, agglutinated flowering tops can best be prepared for microscopical examination by soaking these first in strong alcohol which dissolves some of resin, and then in water. This enables the examiner to separate the small leaves, bracts, twigs, flowers and fruits. The leaves, bracts and twigs can then be sectioned and mounted in alcohol, water or chloral hydrate solution.

The chief diagnostic elements are the rigid, curved, unicellular, non-glandular hairs with a very slender pointed apex, each containing a cystolith in its enlarged

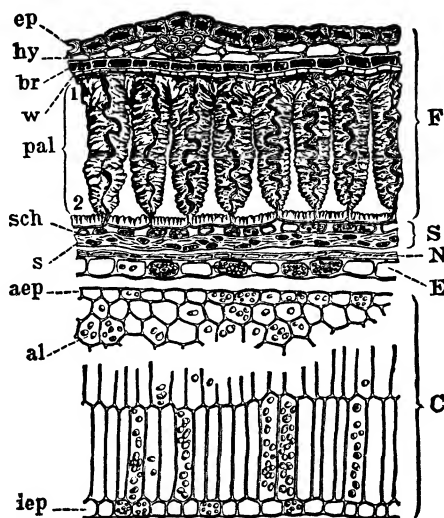


FIG. 122.—Hemp Fruit in transverse section. *F*, pericarp: *ep*, epicarp of stone cells with deeply sinuous walls when viewed in surface sections; *hy*, hypodermis with fibro-vascular bundle; *br.*, brown cells whose walls are zigzag in surface sections; *w*, dwarf cells; *pal*, palisade cells with thickened and wavy walls. *S*, spermoderm: *sch*, outer and *s* inner layer of spongy parenchyma. *N*, perisperm. *E*, endosperm, of a layer of aleurone cells. *C*, cotyledon: *aep*, outer and *iep* inner epidermis. (After Winton and Winton, "The Structure and Composition of Foods, J. Wiley and Sons, Inc.)

basal region (cystolith hairs); rosette aggregates of calcium oxalate from  $5\mu$  to  $30\mu$  in diameter, resin masses, and bract hairs of the glandular type, each with a long, tongue-shaped, multicellular stalk and a globular head of from 8 to 16 cells, the latter containing resin and oil.

**Powdered Drug.**—Light olive to moderate olive brown. Fragments of lower epidermis of leaves with wavy vertical walls and oval stomata, from upper epidermis with straight vertical walls and no stomata; numerous non-glandular hairs which are unicellular, curved, with a very slender pointed apex and an enlarged base usually containing a cystolith; glandular hairs of 2 kinds, one with a short 1-celled stalk, the other with a long multicellular, tongue-shaped stalk, the head being globular and of 8 to 16 cells, fragments of bracts and leaves showing reddish-brown to yellowish-orange laticiferous vessels, fragments of resin; numerous rosettes of calcium oxalate, 5 to  $30\mu$  in diameter, and strands

of spiral tracheae and phloem; fragments of fruits, if present, with palisade-like stone cells having very thick yellowish-brown, finely porous walls and small lumina; fragments of endosperm and embryo of seeds showing numerous oil globules and aleurone grains, the latter up to  $10\mu$  in diameter.

**Constituents.**—Up to 20 per cent. of a brown, amorphous resin called *cannabin* or *cannibinone* which contains a toxic, reddish oily substance from which *cannabinol* and *cannabidol* were isolated; *tetrahydrocannabinol*, a highly active substance; volatile oil containing terpenes and a sesquiterpene called “cannabinene”; choline (an alkaloid), calcium carbonate and calcium oxalate. Cannabis is claimed to contain an oxydase enzyme which appears to oxidize the cannabinol causing gradual deterioration of the drug. Moistening the drug with alcohol and sealing it in a container enhances its keeping qualities and impedes deterioration.

**Action and Uses.**—Cerebral stimulant, analgesic, narcotic, delirifacient. Used as a sedative in migraine, neuralgia, hysteria, cramps of summer diarrhoea, spasmodic cough and in preparations for intestinal disorders. Cannabis acts upon the central nervous system, especially the higher psychic centers, producing mental excitement and exhilaration. In large doses it produces delirium with hallucinations followed by sleep interrupted by dreams, marked weakness and mental depression.

**Dose.**—0.1 Gm. ( $1\frac{1}{2}$  grains).

**Preparations** (unof.).—*Extractum Cannabis*, 0.015 Gm. ( $\frac{1}{4}$  gr.), *Fluid-extractum Cannabis*, 0.1 cc. ( $1\frac{1}{2}$  minims).

#### FIG (FICUS)

**Synonyms.**—Fici, *Ficus Caricæ*; *Ger.* Feigen; *Fr.* Figue.

**Botanical Origin.**—*Ficus Carica* Linné.

**Part Used.**—The clean, sound, partially dried fruit.

**Habitat.**—Western Asia to the Canaries on the west; cultivated extensively in Asia Minor, California, Italy, Spain and Greece.

**Plant.**—A small tree with spreading branches and grayish or red bark. Leaves green, alternate, palmately 3–5 lobed, hairy beneath. Inflorescence consists of a pear-shaped, hollow, fleshy receptacle bearing staminate and pistillate flowers on its inner surface. The fruit is a syconium.

**Production and Commerce.**—The fig is cultivated on a commercial scale in Mediterranean countries, notably Asia Minor, Greece, Italy and Spain, in California, and in the coastal plain from Texas to the Carolinas. It is usually propagated from hardwood cuttings which, when planted in heavy soil, form trees bearing fruit in 2 to 4 years. The average fig tree will not produce good fruit unless caprified. Caprification consists of attaching branches of the caprifig (wild fig) to the cultivated fig tree. The fruit of the caprifig, which is seedless and gall-like, contains large numbers of the eggs of a small wasp, *Blastophaga grossorum*. These, upon hatching, develop either into adult male or female wasps. The wingless males eat their way out of the galls in which they were developed and into the galls occupied by developing females. Here copulation

is followed by the death of the male wasps while the females escape. Spreading themselves over the staminate flowers of the caprifig, they become dusted with pollen. Some of them, chancing to visit the half-grown fruits of the cultivated fig, cut their way through the scaly orifice at the summit and enter the hollowed interior, there to pollinate the female flowers lining its margin. Pollination is

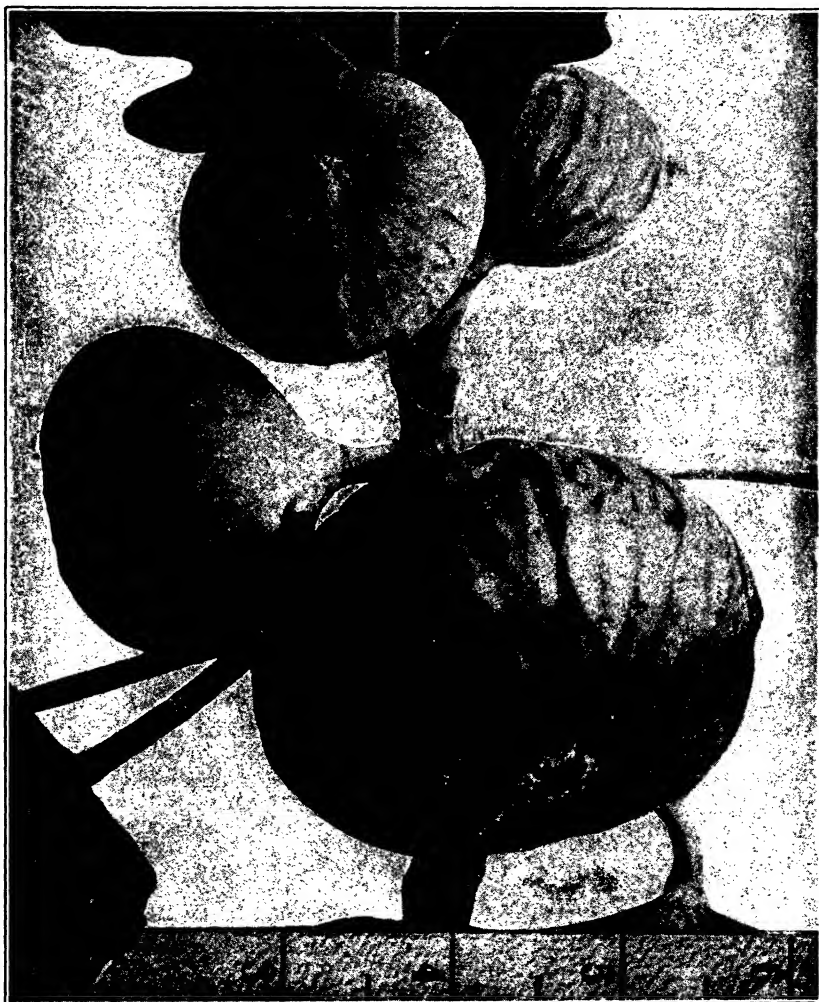


FIG. 123.—Smyrna figs on fruiting-branch. The large fig is fully mature, the others partly so. (After Rixford, Bull. 732, Bureau of Plant Industry, U. S. Dept. of Agriculture.)

followed by fertilization which enables the fruits of the cultivated fig to fully mature. The female wasp dies within the cultivated fig fruit, leaving no progeny. Only those have progeny which visit caprifigs.

*Natural figs* are those which are either allowed to dry on the tree or gathered and dried by artificial heat or by the sun. *Pulled figs* are those which are rendered pliant by pulling and kneading.

Most of the figs used in the United States come from Smyrna and California. Smyrna figs are obtained from trees cultivated in the district about Smyrna. They are gathered when ripe and dried in the sun. Some varieties yield 2 or 3 crops annually. The first crop is borne in early spring on the old wood; the second and third crops are produced later in the season in the leaf axils on the lower and upper portions of the new shoots respectively. Smyrna figs of better quality are manipulated, pulled and extended by armies of workers. They are assorted into 3 grades, viz.: Suzini or first-grade figs (20 per cent.), Elemi or second-grade figs (40 per cent.), a mixture of Elemis and naturals or third-grade figs (40 per cent.). The districts of Erbeyli and Inovassi produce the best fruit. Smyrna figs are forwarded in boxes or drums containing from  $\frac{1}{2}$  to 20 kilos, in which they are packed very carefully; some are also exported in bulk, in sacks, such being generally threaded into a string cluster. Greek figs possess a tough skin and usually are imported in string clusters. Spanish figs are imported from Malaga and Valencia.

Figs of poorer quality are called "hordas." These are exported in large amounts in bulk, in sacks, mainly to central Europe via Trieste where they are used in distilleries or in the manufacture of pseudo- or fig-coffee.

**Description.**—Compressed, irregularly rounded, fleshy fruits from 2.5 to 5 cm. in diameter, light brown to yellow; frequently with an efflorescence of sugar; summit with a small scaly orifice; base with a scar or short stalk; internally hollow, with numerous, small, brownish-yellow, hard akenes which resemble seeds; odor characteristic; taste sweet and distinctive.

**Constituents.**—Up to 62 per cent. of dextrose; fat, proteins, starch, etc.

**Uses.**—Laxative and food. An ingredient in Confection of Senna and Compound Syrup of Figs.

### HUMULUS (HUMULUS)

**Synonyms.**—Hops, Hop Vine, Lupulus; *Ger.* Hopfen; *Fr.* Houblon.

**Botanical Origin.**—*Humulus Lupulus* L.

**Part Used.**—The dried strobile, bearing its glandular trichomes.

**Limit of Impurities.**—Two per cent. of foreign organic matter and 5 per cent. of acid-insoluble ash.

**Habitat.**—North America, Europe and Asia.

**Plant.**—A perennial, dioecious, twining herb whose aerial portion consists of several long, angular, rough-hairy, entwining stems bearing cordate, palmately 3-lobed, occasionally 5-7-lobed, scabrous, dark green, stipulate leaves. Its staminate flowers consist of 5 bracts and 5 stamens and are borne in axillary panicles. Its pistillate flowers are pale green, each consisting of an entire cup-like perianth and a unilocular ovary with a single ovule, and 2 long stigmas, and borne on a leafy conical catkin. Its fruit is an ovate to ovate-cylindrical strobile which consists of a flexuous rachis bearing yellowish-green to pale brown, ovate, membranous, scaly bracts, each enclosing a brown glandular akene.

**Production and Commerce.**—Hops are cultivated in various sections of the United States, Europe, Australia and South America. The strobiles are gathered from the vines when mature in September, carefully dried in kilns by fire and packed in hemp bags or bales for the market. *Hop waste*, consisting of lupulin and broken hops which accumulate in the picking of hops by machines,

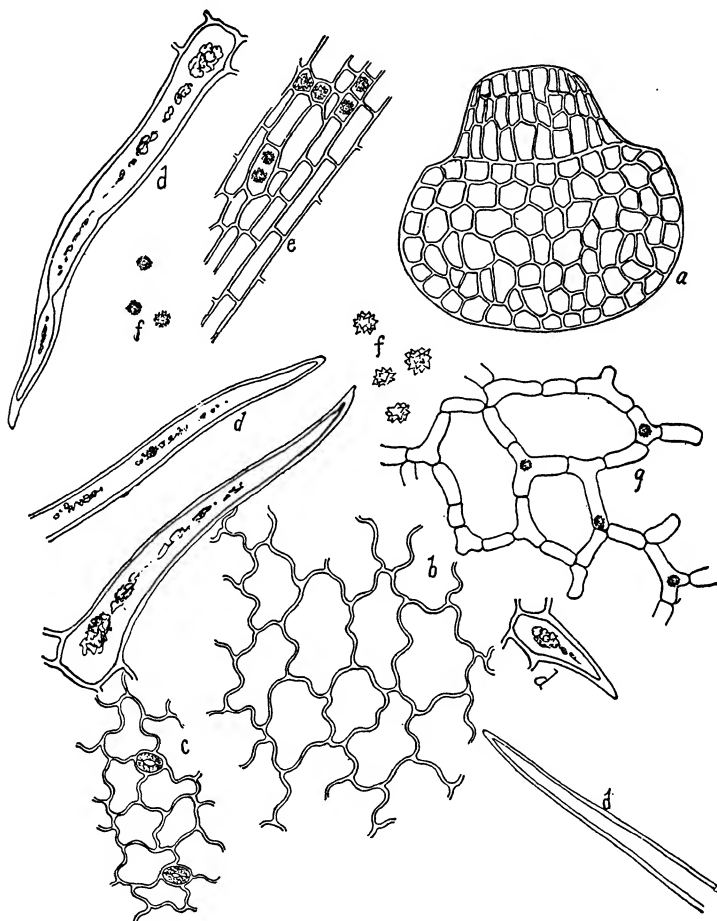


FIG. 124.—Ground *Humulus*. (a) Gland (lupulin); (b) upper epidermal cells; (c) epidermal tissue with stomata; (d) trichomes; (e) parenchyma with crystals; (f) rosette aggregate crystals of calcium oxalate; (g) spongy tissue cells with crystals. (Schneider.)

is used for the production of volatile oil of hops. The latter is used to impart the hop flavor to cereal beverages and in the manufacture of perfumes. Hops are unfit for use in pharmacy when they develop a valeric acid odor. They should be stored in well closed containers, protected from light. The commercial supplies used in the United States have been chiefly obtained from Oregon, Washington, California, Canada, Denmark, Poland, Danzig, Germany, Czechoslovakia, Yugoslavia and Belgium. 5,548,841 lbs. were imported in 1947.

**Description.**—Strobile ovoid-cylindrical, from 3 to 4 cm. in length and up to 3 cm. in width, consisting of a narrow, hairy, flexuous rachis and numerous imbricated, yellowish-green to dusky yellow, obliquely ovate, membranous bracts, the base of each with numerous, orange to yellowish orange, glandular trichomes, and frequently infolded on one side, enclosing a light brown subglobular glandular achene; odor strong and characteristically aromatic, becoming valerian-like on aging; taste aromatic and bitter.

**Powdered Drug.**—Pale yellowish-green to moderate- or light yellowish-brown; rosette crystals of calcium oxalate up to  $24\mu$  in diameter; numerous, unicellular, non-glandular trichomes, somewhat curved and with frequently silicified walls attached to fragments of wavy walled epidermal tissue; glandular hairs with a 3 to 4-celled stalk and a large multicellular, nearly colorless or yellow head the latter containing a yellowish or yellowish orange oleoresin, and from 100 to  $300\mu$  in diameter; fragments of aphid insects exhibiting chitinous walls, frequent; few fragments of parenchyma with large cells containing cystoliths of calcium carbonate; fragments of spongy parenchyma, some of the cells of which contain rosette crystals; fragments of epidermis with wavy vertical walls, some of the fragments exhibiting stomata, others hairs; few spherical, spinose pollen grains up to about  $24\mu$  in diameter.

**Constituents.**—*Volatile oil* (0.3 to 1 per cent.) containing myrcene and humulene; *lupamaric acid* (bitter principle); resins, tannin, lupuline, trimethylamine, calcium oxalate, salts of citric and malic acids, etc.

**Uses.**—Calmative, stomachic and tonic.

**Average Dose.**—2 Gm. (30 grains).

**Preparation.**—Fluidextractum Humuli N.F. VII, 2 cc. (30 minims).

#### LUPULINUM (LUPULIN)

**Botanical Origin.**—*Humulus Lupulus* L.

**Part Used.**—The glandular trichomes separated from the strobiles.

**Standard of Assay.**—Not less than 60 per cent. of non-volatile extractive soluble in ether, N.F. VII.

**Ash.**—Not more than 10 per cent. acid-insoluble.

**Commercial.**—Lupulin is imported from Germany, Czechoslovakia and Canada.

**Description.**—A bright orange to yellowish-orange granular powder, having the characteristic odor and taste of hops, becoming dark reddish-brown in color and valerian-like in odor on aging, when it is unfit for use. It floats when placed in water. The best lupulin is amber colored. The drug should be kept in well closed containers, protected from light.

**Histology.**—The glandular trichomes, when viewed from the side, resemble in outline the sporophore of a toadstool just before the veil has been rent. In this view each consists of a cup- or bowl-shaped, multicellular head consisting of a single layer of angular, secreting cells having the form of a shallow-cup and an upraised thin cuticle, beneath which is a globular mass of yellow or greenish-yellow oleoresin. When viewed from the top, each has a circular

outline. In this view a marginal layer of cells of the bowl of the head is in sharp focus while the other parts are not clear.

**Adulterant.**—Floor sweepings of hop bins, which are low in ether-soluble resin and high in ash.

**Constituents.**—*Volatile oil*, resin, tannin, asparagin, choline, etc.

**Use.**—Calmative, chiefly in the form of the unofficial fluidextract.

**Average Dose.**—0.5 Gm. (8 grains).

### SANTALACEÆ (SANDALWOOD FAMILY)

Herbs, shrubs or trees having entire exstipulate leaves sometimes reduced to scales, cymes of actinomorphic flowers, drupaceous or nut-like fruits and albuminous seeds. Many are parasitic on stems or roots of other plants.

#### SANTALUM ALBUM (WHITE SANDALWOOD)

**Synonyms.**—Sandalwood, Yellow Sandalwood, *Lignum Santali*, White Saunders; *Fr.* Bois de Santal Blanc, Santal Citrin; *Ger.* Weisses oder Gelbes Sandelholz.

**Botanical Origin.**—*Santalum album* Linné.

**Part Used.**—The heartwood.

**Purity Rubric.**—It yields not less than 3.5 cc. of volatile oil of white sandalwood for each 100 Gm. of drug and contains not more than 1 per cent. of foreign organic matter. N.F. VII.

**Habitat.**—India and Malay Archipelago.

**Plant.**—A small evergreen tree growing to the height of about 30 feet, with grayish-brown bark, smooth ovate leaves and small, yellow, pink or violet flowers borne in cymes.

**Production and Commerce.**—The trees are cultivated on a large scale in Mysore and Madras under government supervision. The heartwood is obtained by uprooting trees with thick trunks, removing the bark and sapwood from the trunk and larger branches and roots and sawing or cutting the heartwood into billets or logs. Most of the drug entering this country is imported from British India, Ceylon and British East Africa. The oil is imported from France.

**Description.**—In billets, pieces or chips of varying shapes and sizes, heavy, hard but splitting easily, color light yellowish-brown to weak yellowish-orange; transverse sections with alternating light and dark concentric zones nearly equal in diameter, with numerous pores and traversed by many very narrow medullary-rays; odor characteristic, aromatic, persistent; taste peculiar, strongly aromatic.

**Histology.**—When examined under the microscope, sections show the numerous medullary-rays from 1 to 4 cells wide, the cells thick-walled and radially marked; the wood wedges consisting largely of wood fibers with pointed ends and sometimes containing starch grains up to 15 $\mu$  in diameter; tracheæ with bordered pores, usually solitary; large parenchyma and thick-walled secretion



vessels; cells containing single crystals of calcium oxalate up to  $30\mu$  in length; the oil in globules adhering to the walls of the tracheæ and parenchyma cells. The powder is rich in the medullary-ray cells.

**Constituents.**—Volatile oil (3 to 5 per cent) official in the N.F. as **Santal Oil**, *Oleum Santali*, and *Sandalwood Oil*. It is also called East Indian Sandalwood oil. This oil, distilled with steam from the dried heartwood, is somewhat viscid, of pale yellow color, with a sp. gr. of 0.965 to 0.980 at  $25^{\circ}\text{C}$ . and an optical rotation of not less than  $-15^{\circ}$  and not more than  $-20^{\circ}$  at  $25^{\circ}\text{C}$ . It yields not less than 90 per cent. of alcohols calculated as santalol [ $\text{C}_{15}\text{H}_{23}\text{OH}$ ]. It should be stored in tight containers protected from light and excessive heat.

**Use.**—Sandalwood is used in the arts and as a source of Santal Oil, the latter being used in medicine as a genito-urinary stimulant and disinfectant, and less frequently as an expectorant in bronchitis. It is also used in the perfume industry.

**Average Dose.**—4 Gm. (60 gr.); of *Oleum Santali*, N.F., 0.5 cc. (8 minims).

*Australian Sandalwood Oil*, official in the British Pharmacopœia, is a volatile oil prepared by distillation and rectification from the wood of *Eucarya spicata* Sprague and Summerhayes (Fam. *Santalaceæ*), a tree native to Western Australia. It contains sesquiterpene alcohols called fusanols and is used for the same purposes as East Indian Sandalwood Oil. Dose, 5 to 15 minims.

#### LORANTHACEÆ (MISTLETOE FAMILY)

Most of the members of this family are woody shrubs, parasitic on trees; leaves opposite or whorled, entire, simple, exstipulate, sometimes reduced to scales; flowers hermaphroditic or dioecious, the calyx annular or cup-like, adnate to the ovary; petals disjoined or united into a tube, often split down one side, stamens equal in number to the petals and inserted on their base, the anthers dehiscent by pores or terminal slits: nectar disk present or absent; ovary inferior with simple style or sessile stigma; fruit a berry or drupe with a solitary seed devoid of testa and containing copious endosperm and a straight embryo.

#### PHORADENDRON (AMERICAN MISTLETOE)

Phoradendron is the entire plant of *Phoradendron flavescens* (Pursh) Nutt., a yellowish-green woody parasite growing on various deciduous trees from New Jersey and eastern Pennsylvania to Florida and westward.

**Description.**—The drug occurs as branched and unbranched segments of stems and twigs, entire and broken leaves and occasional fruits; stems yellowish-green or brownish-green, wrinkled longitudinally: leaves thick, obovate, coriaceous, glabrous, irregularly wrinkled: odor heavy and disagreeable, when crushed: taste bitter and astringent.

**Action and Uses.**—Phoradendron acts as a powerful stimulant to smooth muscle, producing a rise in blood pressure and increasing the contractions of the intestine and uterus. It has been recommended as an oxytocic in post

partum hemorrhage and menorrhagia and as a circulatory and uterine stimulant.

Dose.—1 to 5 grains.

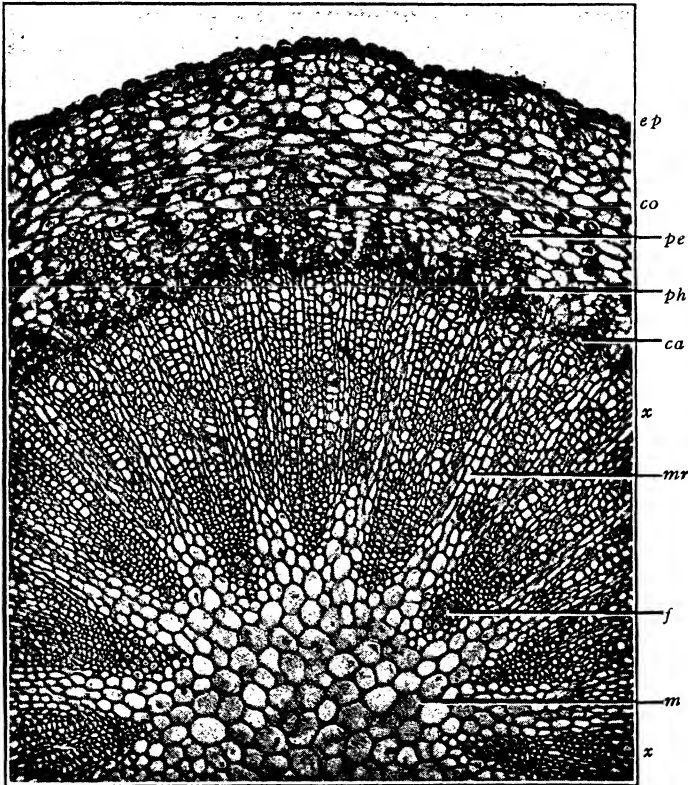


FIG. 125.—*Phoradendron flavescens*. Transverse section of stem of American Mistletoe,  $\times 40$ . *ep*, epidermis; *co*, cortex; *pe*, pericycle with isolated groups of fibers; *ph*, phloem; *ca*, cambium; *x*, xylem; *mr*, medullary ray; *f*, wood fibers; *m*, medulla.

#### VISCUM (EUROPEAN MISTLETOE)

European Mistletoe is the dried entire plant of *Viscum album* L., an ever-green shrub of yellowish-green color with jointed stems, opposite to whorled leaves and 1-seeded berry fruits, growing parasitically upon various deciduous trees, especially apples, oaks, beeches, lindens and birches. *Viscum* contains an acid and a neutral saponin, a volatile alkaloid ( $C_8H_{11}N$ ), a soft resin called viscin, a resin-alcohol called visciresinol, cholin, glucose, etc. It is used for the reduction of blood pressure in arteriosclerosis in the form of various galenical preparations, chiefly in Europe and Asia.

#### ARISTOLOCHIACEÆ (BIRTHWORT FAMILY)

Herbs or twining semi-woody or woody plants, having more or less swollen nodes from which spring cordate or reniform or ovate, exstipulate leaves.

Stems of the woody species in cross section showing broad medullary rays. Flowers regular (*Asarum*, etc.) or irregular (*Aristolochia*) often offensively smelling. The calyx often enlarged and petaloid, often tubular, the limb 3-lobed or unilateral, lobed or entire; stamens many to 6, epigynous; ovary usually inferior 6 to 4 celled; styles short and united into a column ending in 3 stigmatic lobes. Fruit a capsule. Seeds with copious albumen and minute embryo. Among the outstanding histological characteristics are the presence of secretory cells usually with suberized walls and aromatic volatile oil content, and calcium oxalate which occurs in some species in the form of small prisms or rosette aggregates.

#### SERPENTARIA N.F. (SERPENTARIA)

**Synonyms.**—(1) Virginia Snakeroot; (2) Texas Snakeroot; *Ger.* Virginische Schlangenwurzel; *Fr.* Couleuvrée de Virginie.

**Botanical Origin.**—(1) *Aristolochia Serpentina* Linné and (2) *Aristolochia reticulata* Nuttall.

**Part Used.**—The dried rhizome and roots.

**Purity Rubric.**—Not more than 10 per cent. of its overground stems and not more than 2 per cent. of other foreign organic matter; it yields not more than 10 per cent. of acid-insoluble ash.

**Habitat.**—(1) Connecticut to Florida, west to Michigan and Missouri, in rich woods. (2) Louisiana to Arkansas, south to Texas, in rich woods.

**Plants.**—Low perennial herbs with slender stems branched at the base, alternate, ovate or cordate or hastate leaves, and purplish flowers borne on short stalks near the ground with no corolla and with a calyx shaped like the letter S. The fruit is a 6-valved, septicidally dehiscent capsule containing flat seeds. *Aristolochia reticulata* differs from *A. Serpentina* in having a larger rhizome with fewer and thicker rootlets, and thicker leaves with more prominent reticulations and shorter petioles.

**Production and Commerce.**—There are two commercial varieties of the drug, viz.: Virginia Snakeroot from *Aristolochia Serpentina* and Texas Snake-root from *A. reticulata*. The chief bulk of the drug is collected in Virginia, North and South Carolina, Tennessee and Georgia, and represents Virginia Snakeroot. Texas Snakeroot comes largely from Texas. The drug is collected in autumn.

**Description.**—Rhizome oblique, subcylindrical, curved, from 10 to 30 mm. in length and from 1 to 2.5 mm. in diameter (Virginia Snakeroot) or 10 to 40 mm. in length and 2 to 4 mm. in diameter (Texas Snakeroot); externally weak reddish brown to moderate brown with short stem-bases on upper surface and bearing numerous long, thin, moderate brown to light yellowish-brown roots on its lower and lateral surfaces; fracture short; internally bark dark brown, wood weak yellowish orange to weak yellow and showing broad eccentric wedges; pith whitish; odor camphoraceous, terebinthinate; taste aromatic and bitter. The drug usually contains some leaves of the plant yielding it.

**Histology.**—Transverse sections of the *rhizome* are characterized by a suberized epidermis, a cortex of 10 to 15 rows of parenchyma, a narrow inner bark, exhibiting a more or less continuous arc of sclerenchyma fibers, a cambium, a broad, porous xylem with wood wedges separated by medullary-rays, up to about 8 cells wide, the walls of the latter being lignified and porous, and an eccentric pith with its cells showing lignified and porous walls.

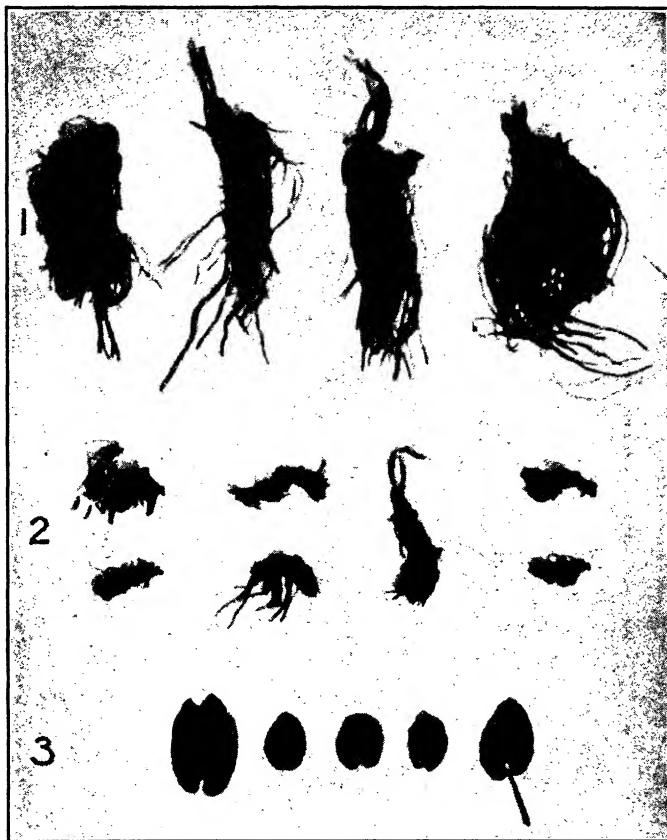


Fig. 126.—*Serpentaria*. 1. Rhizomes and roots; 2, rhizomes deprived of most of their rootlets; 3, leaves of Texas *Serpentaria*. All found in a commercial shipment of the crude drug.  $\times \frac{1}{4}$ .

The *aerial stem* exhibits a more or less continuous arc of sclerenchyma fibers in the pericycle, a few non-glandular hairs whose terminal cells are often recurved, and an interrupted circle of 6 to 10 bundles. Simple and 2- to 4-compound starch grains the individual grains of which are spherical or plano-convex, frequently with a central cleft and up to  $18\mu$  in diameter occur in the cells, of the cortex, pith and medullary rays.

Transverse sections of the root exhibit primary root structure as follows: An epidermis with root hairs; a broad zone of cortex with thick-walled paren-

chyma containing starch grains; an endodermis with irregularly thickened radial walls; a thin-walled pericycle; a tetrarch radial bundle and central pith.

**Powdered Drug.**—Pale brown to dusky yellow. The diagnostic elements are the numerous simple and 2- to 4-compound starch grains, the individual grains spheroidal or plano-convex with a central hilum and up to  $18\mu$  in diameter, the lignified tracheæ, fibers, medullary-ray cells and pith cells, and the uniseriate, non-glandular hairs from the stem.

**Constituents.**—*Volatile oil* containing *borneol*; *bitter principle* called *aristolochin* (serpentarin); an alkaloid called *aristolochine*; resin, tannin, starch, etc.

**Use.**—Aromatic bitter.

**Average Dose.**—1 Gm. (15 grains).

**Preparation.**—Compound Cinchona Tincture N.F., 4 cc. (1 fl. dr.).

**Substitute.**—The rhizome of *Jeffersonia diphylla* or Twin Leaf (Fam. *Berberidaceæ*) which is devoid of aroma and possesses a bitter, acrid taste.

#### ASARUM (ASARUM)

**Synonyms.**—Wild Ginger, Canada Snakeroot; *Ger.* Canadische Haselwurzel; *Fr.* Asaret du Canada.

**Botanical Origin.**—*Asarum canadense* Linné.

**Part Used.**—The dried rhizome and roots.

**Purity Rubric.**—It contains not more than 5 per cent. of foreign organic matter and yields not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—North and central United States, in rich woods.

**Plant.**—A soft, pubescent, perennial herb whose aromatic bitter rhizome bears several kidney-shaped membranous leaves with long petioles and bell-shaped flowers having a brownish-purple calyx. The fruit is a capsule.

**Collection.**—The rhizomes are dug in the spring, cleaned, most of the roots removed and dried. The commercial supplies come from Indiana, North Carolina, Michigan and Virginia.

**Description.**—Of horizontal growth, occasionally branched, two-edged when young, quadrangular when older, finely striate, usually more or less twisted, from 5 to 17 cm. in length and from 2 to 4 mm. in thickness; nodes enlarged with irregular scars from petioles and remains of pedicels; internodes with annular scars from scales; weak reddish-brown to moderate yellowish-brown externally, fracture short, internally pale brown to pale yellow, starchy or resinous; attached roots few, up to 7 cm. in length and not over 1 mm. in thickness, each having a 4- to 6-rayed fibrovascular bundle. Odor aromatic recalling ginger and serpentaria, non-irritating upon heating; taste pungent and slightly bitter.

**Powdered Drug.**—Pale brown to light yellowish-brown; numerous simple and 2- to 4-compound starch grains, many with a distinct central hilum, the individual grains from  $3\mu$  to  $20\mu$  in diameter; fragments of brownish epidermal cells with occasional uniseriate non-glandular hairs; tracheæ with scalariform, reticulate or spiral thickenings; fragments of parenchyma, some of the cells of which have suberized walls and contain oil or resin.

**Constituents.**—*Volatile oil, resin* possessing the gingery taste of the drug, an odorous principle called *asarol*, a yellow coloring principle called *asarin*, starch, gum, etc.

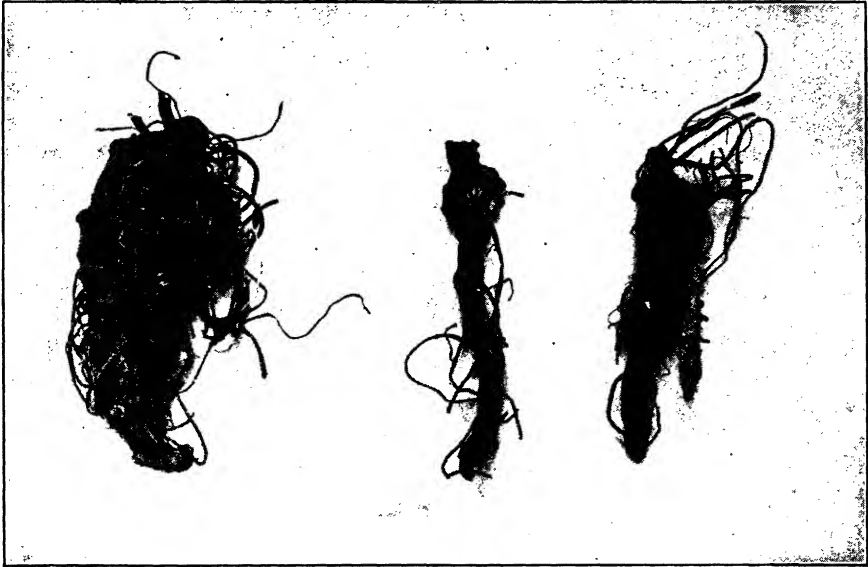


FIG. 127.—Asarum,  $\times \frac{9}{18}$ . (Photograph by Stoneback.)

**Use.**—Aromatic bitter and carminative.

**Average Dose.**—2 Gm. (30 grains).

**Preparation.**—Syrupus Asari Compositus, N.F. VII, 4 cc. (1 fl. dr.).

#### POLYGONACEÆ (BUCKWHEAT FAMILY)

Usually herbs (*Polygonum*, *Rheum*, *Rumex*, etc.), rarely trees (*Coccoloba uvifera* and *C. platyclada*) or shrubs (*Muhlenbeckia*, *Brunnichia*) having strong vertical tap roots and spreading secondary roots more or less provided with tannin compounds. Stems elongate, green, to woody, rarely flattened, leathery, phylloidal (*Muhlenbeckia platyclada*), still more rarely tendriform (*Antigonum leptopus*). Leaves alternate, rarely opposite or whorled (*Eriogonum*), entire, rarely lobed (*Rheum palmatum*, *Rumex acetosella*), petiolate, rarely sessile, and stipulate. Stipules fused and forming a greenish, tubular, membranous upgrowth (*ochrea*) which sheathes the stem. Inflorescence racemose with many dense scorpioid or helicoid cymes, which in some forms condense into single flowers. Flowers regular, pentamerous, with simple calyx, becoming trimerous with two whorls of 3 sepals each. Stamens varying from 15 or 12 to most usually 9 or 6, more rarely from 5, 4, 3 to 1 (*Kaenigia*), hypogynous, more rarely by enlargement of receptacle and slight fusion of sepals, perigynous. Pistil tri- to bicarpellate, often 3- to 2-sided; ovary 1-celled with 1 ovule. Styles 3, rarely 2, radiating-penicillate in wind-pollinated inconspicuous

flowers, becoming condensed, knob-like in conspicuous insect-pollinated flowers. Fruit a triangular or biconvex akene often crowned by persistent styles and surrounded by persistent closely applied sepals. Seeds solitary, albuminous, with straight embryo, or in *Rumex*, curved embryo.



FIG. 128.—*Rheum palmatum* L. var. *tanguticum* Maxim., a source of some of the Chinese Rhubarb. Leaf.  $\times \frac{1}{2}$ .

The following histological features characterize this family: tracheæ with simple pores; wood fibers with simple pits; cork either superficial or internal; calcium oxalate in rosette aggregates or solitary crystals; mucilaginous epidermal cells in leaves. Vascular bundles occur in the pith of species of *Rheum* and *Rumex* with xylem and phloem inversely oriented.

## RHUBARB U.S.P. (RHEUM)

**Synonyms.**—Rhubarb Root, Turkey- or Chinese-Rhubarb, *Rhizoma Rhei*; *Ger.* Rhabarberwurzel; *Fr.* Rhabarbarum.

**Botanical Origin.**—*Rheum officinale* Baillon, *Rheum palmatum* L. or other species (excepting *R. rhaponticum* L.) or hybrids of *Rheum* grown in China and Tibet.

**Part Used.**—The dried rhizomes and roots, deprived of periderm tissues.

**Standard of Assay.**—Not less than 30 per cent. of diluted alcohol-soluble extractive.

**Habitat.**—China, Tibet, and Chinese Tartary.

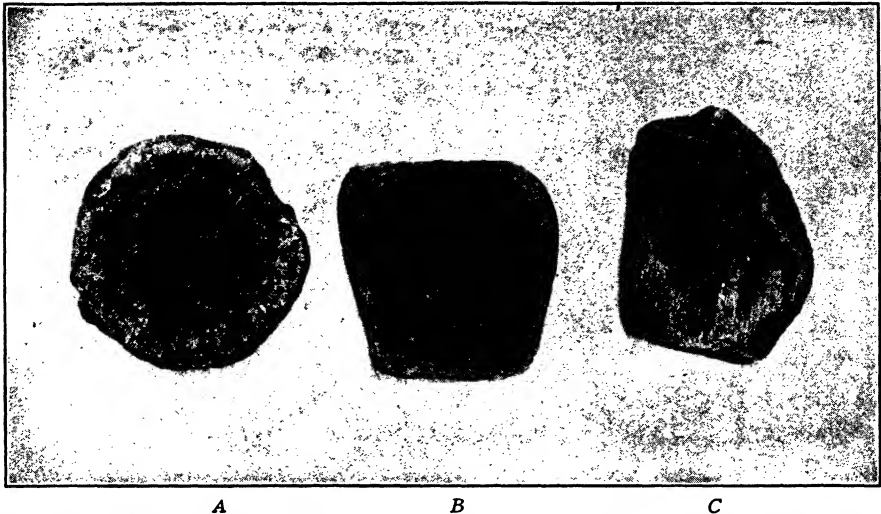


FIG. 129.—Shensi Rhubarb,  $\times \frac{1}{4}$ . A and C, two views of Round variety; B, Flat variety.  
(Photograph by Stoneback.)

**Plants.**—Perennial herbs resembling our garden rhubarb excepting for their lower growth and shape of their leaf blades. Their underground portion consists of a strong vertical rhizome with fleshy, spreading roots. The above-ground portion consists of a number of long petioled leaves that arise from the rhizome in the spring, and flower shoots bearing elongated leafy panicles that are crowded with greenish-white, white to red flowers. The lamina is cordate to somewhat orbicular, entire or coarsely dentate (*Rheum officinale*) or palmately lobed (*R. palmatum*) or deeply incised (*R. tanguticum*). The fruit is an achene with 3 broad thin wings and surrounded at its base by the remains of the perianth.

**Production and Commerce.**—The production of Rhubarb extends over a large area of China. The chief localities are the northern provinces, Shensi, Shansi, Chihli and Honan, the northwest province of Kansu, the Mongolian province of Tsing-hai, and the mountainous districts of the western province of Szechuen. *Rheum officinale* is collected chiefly in the mountainous country



separating Tibet from the province of Szechuen and extending eastward to Hupeh. Since World War II, some supplies of drug found by the author to represent Rhubarb from *Rheum officinale* have been collected near the city of Yachow in the southwestern mountainous region of Szechuen province and shipped to this country from Shanghai. *Rheum palmatum* is abundant in the province of Kansu where it is collected in commercial quantities. A large amount of rhubarb probably derived from this species is collected near lake Kokonor in Tibet. The rhizome and roots are dug up late in September from plants 8-10 years old, washed, the crown and small branches removed and, after the removal of most of the bark, are either cut into pieces or segments and kiln or sun dried, or the segments may be bored with holes and suspended on strings to dry. Most of the drug is shipped through Hankow to Shanghai from whence it is exported to Europe in zinc lined wooden chests. Smaller quantities are exported from Tientsin, Canton, Amoy, Foochow and Ning-po. Shensi Rhubarb is esteemed as the best variety. "Black Hearted" Rhubarb consists of pieces of the drug that possess dark or hollow central areas, due to the decay of these regions in the process of drying by artificial heat. The exterior of the pieces becomes hardened before the interior has lost all of its moisture, and so the pieces decay in the center. Before milling, the decayed portions should be removed with a chisel or file.

The commercial varieties of Chinese Rhubarb imported into this country are Shensi, Canton and High Dried. Each of these occurs in "flats" or "common rounds."

High Dried Rhubarb is dried on strings and shows a hole running through the rhizome or root.

Common Round Rhubarb consists of segments of the entire root or rhizome. Flats are large rhizomes or roots split in two lengthwise.

The Shensi Rhubarb, yielded by *Rheum palmatum*, is esteemed as the finest variety. It occurs in flats and rounds and is characterized by being firmer, heavier, deeper colored and more compact than the Canton variety, usually with a bright yellow coat of powder, and showing well marked surface reticulations, with a marbled often pink-colored interior, when fractured with a mallet, and an agreeable odor and taste. Star-spots are very distinct on the smooth transverse surface.

Canton Rhubarb, also occurring in flats and rounds, is lighter in weight and color, less compact, and more fibrous in character. Its surface reticulations are less marked. Its fractured surface is devoid of the strikingly marbled character of the Shensi variety, appearing more uniformly granular in aspect. Its odor and taste are empyreumatic and less agreeable. The star spots are less distinct.

High Dried Rhubarb may be distinguished from the two preceding commercial varieties by its rougher and duller coat, more empyreumatic odor, and tendency to break obliquely when fractured. It includes Se-Tschouen flats and common rounds. During 1946, 181,664 pounds of Rhubarb were imported into this country.

**Culture.**—Rhubarb may be propagated from seed or by dividing the crown into a number of portions, each bearing a bud. Planting should be done in early spring in a rich, deep soil treated with well rotted manure. The plants should be set 4 to 5 ft. apart each way with their crowns 4 in. beneath the surface. The rhizomes and roots should be harvested in autumn.



FIG. 130.—Rhubarb rhizome. Transversely cut surface showing stellate spots (*rk*) which represent compound fibrovascular bundles. Natural size. (After Berg.)

**Description.**—The drug occurs on the market in sub-cylindrical, barrel-shaped, plano-convex or irregularly formed pieces, frequently showing a perforation, or in cubes or rectangular pieces, the last commonly known as “rhubarb fingers.” It is hard and moderately heavy. The outer surfaces are smooth, longitudinally wrinkled or sunken, yellowish-brown and mottled with alternating striæ of grayish-white parenchyma and brownish or reddish medullary-rays,

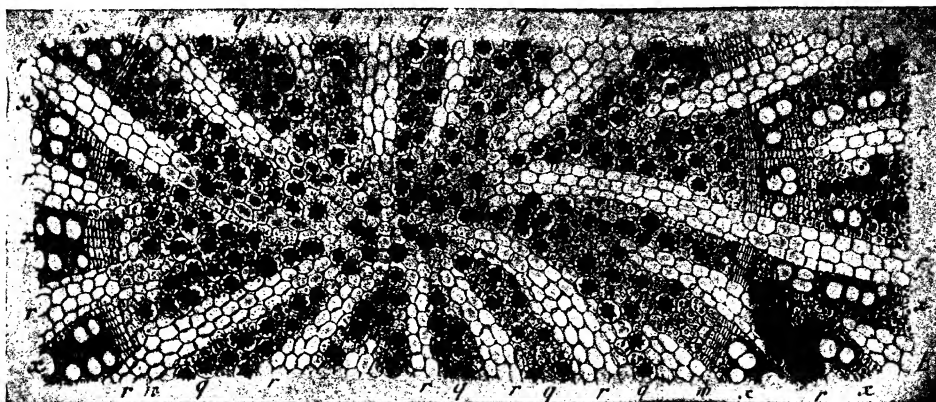


FIG. 131.—Transverse section of a representative portion of a compound fibrovascular bundle of *Rheum* showing cambium ring, *w*; medullary rays, *r*; xylem portions of bundles, *x*; and phloem portions of bundles *q*. Note rosette crystals of  $\text{CaO}$  in parenchyma cells.  $\times 60$ . (After Berg.)

while here and there may be seen brown cork patches and branched scars “star spots” of leaf trace fibrovascular bundles. The fracture is uneven and granular, the fractured surface pinkish-brown in color. The smoothed transverse surface of the rhizome exhibits a cambium line near the periphery traversed by radial lines which represent medullary rays that project for a short

distance within it. The large area within this circle of medullary rays contain stellate vascular bundles from 2 to 4 mm. in diameter which are arranged in a more or less continuous circle in *Rheum palmatum* or scattered irregularly in *Rheum officinale*. The odor is aromatic. The taste is characteristically bitter

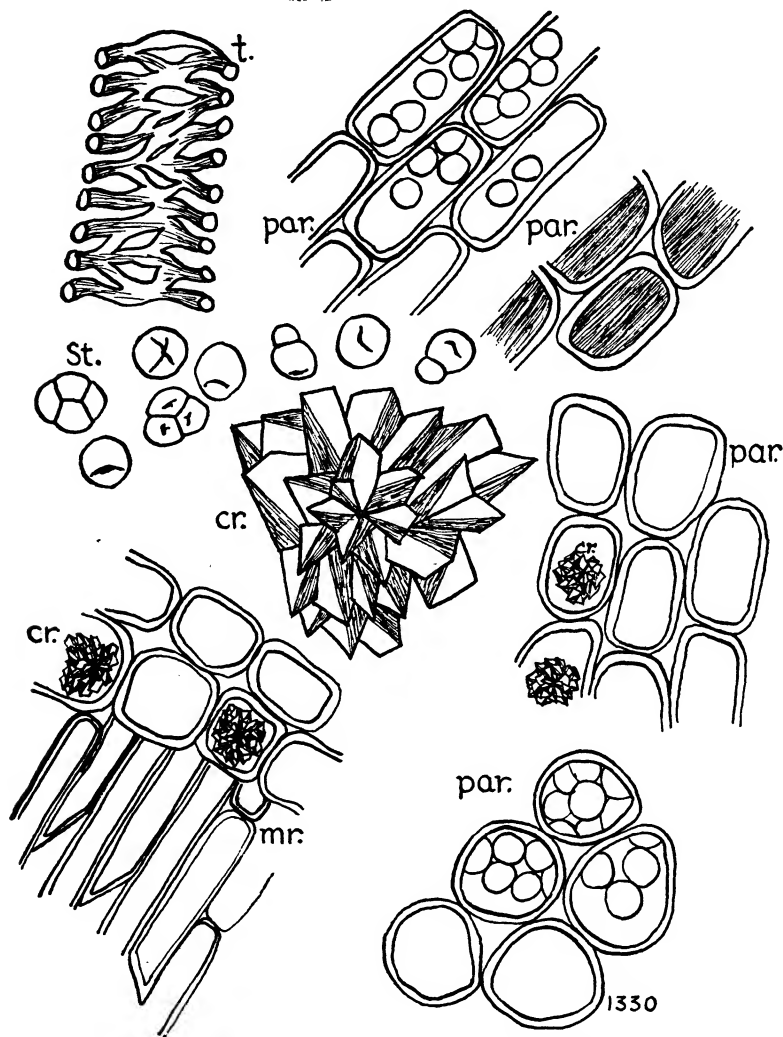


FIG. 132.—Powdered Rhubarb. *par.*, parenchyma, *t.*, fragment of reticulate trachea, *st.*, starch grains; *cr.*, rosette aggregate crystal of calcium oxalate; *mr.*, medullary ray associated with parenchyma. (Drawing by Izzo.)

and astringent. When chewed a gritty sensation is experienced and the saliva is colored yellow.

**Histology.**—Sections of Rhubarb are characterized by regular dicotyl structure, excepting the pith region of the rhizomes. Passing from without inward we note occasional patches of cork cells and cortex, a phloem, cambium,

xylem and pith. The medullary rays are wavy and 2 to 4 cells in width. Tracheae are scattered and in small groups. The xylem consists of a matrix of wood parenchyma and resembles the phloem and cortex regions in that the cells possess either starch, tannin or large rosette crystals of calcium oxalate. Imbedded in the parenchyma near the cambium line and mostly in the pith are a number of compound ("stellate") fibrovascular bundles. Each of these consists of a small circle of open collateral bundles separated from each other by yellowish-brown medullary-rays containing anthraquinone derivatives. The bundles differ from the ordinary open collateral bundle in showing phloem inside and xylem outside the cambium. In *R. officinale* the compound bundles ("stellate spots") are scattered through the pith, whereas in *R. palmatum* they are arranged mostly in a ring, the remainder being scattered on either side of the ring. Sections of the root are devoid of the compound bundles and pith and the xylem is radiate.

**Powdered Drug.**—Dusky yellowish-orange to moderate yellowish-brown. It is colored red with alkalis. Under the microscope it shows numerous starch grains, spherical, single or 2- to 4-compound, the individual grains from  $2\mu$  to  $25\mu$  in diameter, fragments of non-lignified, reticulate and spiral tracheae, parenchyma cells containing starch grains or tannin masses, large rosette aggregates of calcium oxalate frequently over  $100\mu$  in diameter, occasionally attaining a diameter of  $190\mu$ , and medullary-ray cells containing an amorphous yellow substance, insoluble in alcohol but dissolving in ammonia T.S. with a pink color.

**Constituents.**—An *anthra-glycoside* or anthra-glycosides yielding oxidation products, the anthraquinone derivatives, *chrysophanic acid* (di-hydro-oxy-methyl-anthraquinone), *emodin* (tri-hydro-oxy-methyl-anthraquinone), *rhein* (tetra-hydro-oxy-methyl-anthraquinone), *aloe-emodin*, *emodin monomethyl ether*; the astringent principles *rheo-tannic acid*, *glucogallum* (a glucoside), *gallic acid*, *catechin*; rheinolic acid, verosterol, calcium oxalate, starch, etc. The anthraquinone principles are found in the cells of the medullary-rays.

According to Kroeber,\* the drug obtained from *Rheum palmatum* is much more active than that obtained from *Rheum officinale*. He found 2.268 per cent of anthraquinones in *R. palmatum* and 3.937 in *R. officinale*. It appears that the percentage of anthraquinones present is not proportionate to the activity of the drug.

**Uses.**—Purgative with secondary astringent action in indigestion; stomachic bitter, laxative.

**Average Dose.**—1 Gm. (15 grains).

**Preparations.**—Rhubarb Extract, N.F., 0.5 Gm.; Rhubarb Syrup, N.F., 10 cc.; Aromatic Rhubarb Syrup, U.S.P., 10 cc.; Aromatic Rhubarb Tincture, U.S.P., 4 cc.; Rhubarb Fluidextract, N.F., 1 cc.; Alkaline Rhubarb Elixir, N.F., 4 cc.; Sweet Rhubarb Tincture, N.F., 4 cc.; Compound Rhubarb Powder, N.F. (Gregory's Powder), 2 Gm.; Rhubarb and Soda Mixture, N.F., 4 cc.

\* Kroeber, L.: *Schweiz. A poth. Ztg.* vol. 61, p. 221.

**Adulterants.**—The crude drug has been found adulterated with the rhizomes and roots of *Rheum Rhaponticum* L. and *R. undulatum* L. or *R. compactum* L. hybrids, known as Rhapontic, European, English or Garden Rhubarb. These appear shrunken, are often deeply wrinkled or furrowed on the exterior and often show considerable exterior cork. They are more astringent and mucilaginous and contain less calcium oxalate and so are not as gritty as the official article. They are likewise lighter in color and weight and contain the crystalline glycoside *rhaponticin*, *chrysophanic acid*, etc., but no emodin, aloë-emodin or rhein. Rhapontic Rhubarb has also been substituted for the official article. Its outer surface is wrinkled or furrowed and its interior shows a pinkish or pink and orange coloration. Some of the pieces are hollow or cracked in the center and exhibit a pink radiate wood with concentric rings.

Cross sections of its rhizomes are distinguished microscopically from those of the official drug by showing a diffuse circle or scattering of isolated compound fibro-vascular bundles ("stellate spots"). Cross sections of Rhapontic Rhubarb roots exhibit a radiate xylem. The medullary-rays are straighter, giving the transversely cut surfaces of both rhizomes and root a more radiate appearance, and the drug possesses none of the reddish color so characteristic of official Rhubarb.

Under filtered ultra-violet light, pure Rhapontic Rhubarb gives a violet or lavender fluorescence whilst pure Chinese Rhubarb takes on a velvety brown. Rhaponticin also gives a violet to purple fluorescence under ultra-violet light.

Powdered Rhubarb has been adulterated with (1) the powdered root of Canaigre or *Rumex hymenosepalus*. The parenchyma cells of the latter have reddish walls and contain spheroidal and ellipsoidal starch grains up to  $15\mu$  in diameter; (2) exhausted rhubarb, detected by altered rhubarb starch grains and decrease in the amount of aqueous or dilute alcoholic extract; (3) wheat middlings; (4) wheat flour colored with turmeric.

#### INDIAN RHUBARB (RHEUM INDICUM)

**Synonym.**—Himalayan Rhubarb.

**Definition.**—The dried rhizomes and roots of *Rheum Emodi* Wallich, *Rheum Webbium* Royle, *Rheum Moorcroftianum* Royle and *Rheum spiciforme* Royle (Fam. *Polygonaceæ*).

**Plants.**—Perennial herbs native to the Himalaya Mts. of India.

**Commercial.**—Indian Rhubarb is gathered in the Himalayan mountain sections of India including Dera Afghanistan, Punjab, Nepal and Kashmir. The rhizome and roots are washed, cut into segments and dried. *Rheum Emodi* and *R. Webbium* appear to have been the principal sources of drug received in this country, with the former representing most of the article imported from India during World War II.

**Description.**—In unpeeled or partially decorticated subcylindrical or irregular pieces, mostly of roots from 2 to 20 cm. in length and from 1.5 to 8 cm. in diameter; externally dark brown to purplish brown, purplish, where abraded,

deeply and irregularly longitudinally wrinkled to fissured, some pieces twisted, the rhizome segments with annulations; fracture short and irregular, the fractured surface not marbled; internally showing a dull brown to yellowish brown bark, a dark, irregularly wavy, cambium line and a yellowish brown, radiate wood, the rhizome showing in addition a central, yellowish brown pith; odor feebly to fragrantly aromatic; taste bitter and astringent.

**Powdered Drug.**—Yellowish brown to brownish yellow; starch grains numerous, simple and 2- to 3-compound, rarely up to 4-compound, the individual grains mostly up to  $27\mu$ , spheroidal, plano-convex, angular convex, rarely oval or pyriform, with centric to excentric hilum, the latter either circular, triangular, crescentic, resembling the wings of a bird in flight or irregularly cleft; starch grains exhibiting distinct polarization crosses under polarized light; numerous fragments of starch and crystal bearing cells; numerous rosette aggregates of calcium oxalate usually up to  $100\mu$ , occasionally up to  $152\mu$  in diameter; fragments of reticulate and spiral tracheæ and wood fibers with lignified walls; medullary ray cells containing an amorphous yellow to brown substance dissolving in ammonia T.S. with a pink to red color; numerous fragments of cork cells with brown amorphous contents.

**Constituents.**—*Emodin*, *chrysophanic acid*, a resinous substance, *tannin*, starch, calcium oxalate, etc.

**Uses.**—As a purgative similar to Chinese Rhubarb.

**Average Dose.**—1 Gm. (15 grains).

#### RUTIN

**Rutin** ( $C_{27}H_{30}O_{16} \cdot 3H_2O$ ) is a flavanol glucoside extracted principally from the leaves of the buckwheat, *Fagopyrum esculentum* Moench (Fam. *Polygonaceæ*).

**Plant.**—The common buckwheat, *Fagopyrum esculentum* is an annual herb native to eastern Europe and western Asia and extensively cultivated in the northern United States and Canada both for its fruits which yield buckwheat flour and as a catch crop to be ploughed under as fertilizer. Its leaves are alternate, hastate to deltoid, long petiolate. Its flowers are white and borne in panicles of racemes or corymbs. Its fruit is a 3-angled achene with a hard pericarp enclosing a seed with mealy endosperm.

**Production.**—Rutin occurs in the garden rue (*Ruta graveolens*), tobacco (*Nicotiana tabacum*), *Hydrangea arborescens*, the pansy (*Viola tricolor*), *Forsythia*, *Eucalyptus macrorhyncha* (up to 8 per cent in dried leaves), *Boronia thujana*, dried leaves 5 per cent, *Boronia serrulata*, dried leaves 6.6 per cent, and in the buckwheat, leaves and flowers 3 to 5 per cent. At present its most economical source appears to be the common buckwheat plant in which Couch and his associates obtained a yield of 3 to 5 per cent from the leaves and flowers and also ascertained the highest yield was in the 3 to 5 blossom stage, decreasing as the plant matured.

Rutin may be extracted from either fresh or dried plant material containing it. The method used in obtaining it from fresh material consists of maceration in alcohol for a day, drawing off the solution, replacing it with fresh alcohol,

allowing it to macerate for 24 hours, concentrating the alcoholic extracts collected by distillation, filtering the cooled distillate, collecting the crude rutin crystals from the filter, dissolving them in water and, by the process of recrystallization obtaining pure rutin. A method used in obtaining rutin from dried buckwheat is as follows: The leaves and flowers are first separated from the stems and ground to a coarse meal. The meal is treated with three 30 minute extractions with hot water which removes 97 per cent of the rutin. The extract is then filtered, concentrated by evaporation in vacuo, the colloidal material including protein coagulated with alcohol and removed by filtration. The filtrate is then evaporated until most of the alcohol is removed when the crude rutin crystallizes out. The crude rutin is purified by recrystallization. When the dried leaves are used for rutin extraction, rapid drying is essential.

**Description.**—Rutin occurs as a yellow, tasteless powder consisting of masses of acicular crystals when examined microscopically; slightly soluble in cold water, considerably more soluble in boiling water, more soluble in ethanol, methanol, acetone and ethyl acetate and very soluble in alkaline solutions; insoluble in ether, chloroform, benzene and petroleum solvents. It darkens on exposure to light. On hydrolysis with dilute acids, rutin yields quercitrin (a flavanol), glucose and rhamnose.

**Uses.**—In decreasing capillary fragility and reducing the incidence of recurrent hemorrhages associated with a state of increased capillary fragility, in diabetic retinitis, pulmonary hemorrhages not caused by tuberculosis, and in various diseases in which weakened capillaries occur.

**Dosage.**—Orally, 20 to 40 mg., repeated 3 or 4 times daily for several weeks or until the capillary fragility index becomes normal.

#### CHENOPODIACEÆ (GOOSEFOOT FAMILY)

Annual or perennial herbs or undershrubs of more or less succulent character and wide distribution, the greater number inhabiting the shores of oceans and salt lakes. Leaves mostly alternate, simple, usually flat, entire, sinuate-toothed or cut, sometimes fleshy, semi-cylindric to cylindric and exstipulate. Flowers small, inconspicuous and greenish, each with a free calyx of from 5 to 2 sepals, no corolla, as many hypogynous stamens as calyx lobes and a pistil with a one-celled ovary and 4 to 2 stigmas. Fruit a utricle. Seeds albuminous (*Chenopodium*) with curved or annular embryo surrounding the mealy albumen or embryo folded, dividing the albumen into two parts or seed exalbuminous with embryo forming a conical spiral (Saltwort). To this family belong the Spinach and Beet and a number of common sea-shore plants such as the Samphire, Sea Blite, Salt Bush, and Saltwort. The pollen grains of many species cause hay fever.

#### CHENOPODIUM (CHENOPODIUM)

**Synonyms.**—American Wormseed, Wild Wormseed, Jerusalem Tea, Mexican Tea, Goosefoot, Jerusalem Oak, Stinking Weed; *Ger.* Amerikanischer Wurmsamen; *Fr.* Ansérine Vermifuge.

**Botanical Origin.**—*Chenopodium ambrosioides* var. *anthelminticum* (Linné) A. Gray.

**Part Used.**—The dried fruits.

**Habitat.**—West Indies, Central and South America. Naturalized in the United States.



FIG. 133.—*Chenopodium ambrosioides* var. *anthelminticum* (Fam. *Chenopodiaceæ*) the fruits of which (utricle) constitute "American Wormseed."

**Plant.**—An aromatic annual or perennial weed growing in waste localities in many sections of the United States and cultivated extensively in Carrol County, Maryland, and to a lesser extent in South Dakota for its oil which is official in the N.F. as *Oleum Chenopodii*. Its leaves are lanceolate or oblong, strongly serrate, the lower being nearly laciniate-pinnatifid. Its flowers are minute, green and clustered in glomerules on almost naked, elongated spikes. Its fruit is a utricle with blackish akene enveloped by a bladdery calyx.



**Production and Commerce.**—American wormseed has been cultivated in Maryland, Virginia, North Carolina, Florida, Indiana and South Dakota. It thrives best when planted in pulverized loamy soil high in potash content and containing a nitrogen-phosphorous ratio of about 1:4. The seeds are sown in the spring in rows 3 to 4 feet apart and lightly covered. When well up the plants are thinned to stand about 18 in. apart in the row. A pound of seed is sufficient for an acre. Shallow cultivation between the rows is essential for a good crop. When grown for the "seeds," the crop should be harvested just before the tops take on a brown color. The plants are mowed down and dried by the fire, after which the seed is thrashed out and cleaned by passing through wire sieves. When grown for the oil, the plants are first cut when they have matured to the stage where most of the seeds have turned dark, and the fresh overground parts of the flowering and fruiting plants subjected to steam distillation. There should be redistillation of the aqueous layer of the distillate. The greatest yield of oil is claimed to be obtained at the time of pollination of the flowers. The oil should yield not less than 65 per cent. of ascaridol. The yield of seed averages about 1000 pounds per acre. Most of the commercial supply of the seed comes from Florida, Virginia, North Carolina and Indiana, while the oil is largely produced in Carrol County, Maryland. It requires about 5000 pounds of dry herb to produce 100 lbs. of oil.

**Description.**—Fruit depressed globular, greenish-yellow or greenish-brown, about 1.5 mm. in diameter, consisting of an outer thin, bladdery and glandular calyx surrounding a lenticular, brownish-black to reddish-black, glossy, seed-like akene; odor distinct, aromatic; taste pungent and bitter.

**Constituents.**—Volatile oil containing *ascaridole* (anthelmintic principle), p-cymene, d-camphor and l-limonene; saponins, etc. Ascaridole is distributed throughout the plant. While the fruits contain the greater portion of it, leaves and stems come second and third, respectively, in percentage content.

**Uses.**—Anthelmintic, for the round and hook worms, in the form of a 5 per cent. decoction, or as the crude drug which is frequently mixed with molasses, or as the official volatile oil.

#### CHENOPODIUM OIL N.F. (OLEUM CHENOPODII)

**Synonym.**—Oil of American Wormseed, *American Wormseed Oil*.

**Definition.**—The volatile oil distilled with steam from the fresh, over-ground parts of the flowering and fruiting plant of *Chenopodium ambrosioides* var. *anthelminticum* (L.) A. Gray (Fam. *Chenopodiaceæ*).

**Standard of Assay.**—Not less than 65 per cent., by weight, of ascaridol [ $C_{10}H_{16}O_2$ ].

**Description.**—A pale yellow to orange-yellow liquid with a peculiar, unpleasant odor and a bitter, burning taste; soluble in 8 volumes of 70 per cent. alcohol; sp. gr. 0.950 to 0.980 at 25°C.; opt. rot.  $-4^{\circ}$  to  $-8^{\circ}$  in a 100 mm. tube at 25°C.; ref. ind. 1.4740 to 1.4790 at 20°C.

**Use.**—Anthelmintic.

**Average Dose.**—As an anthelmintic for adults, single dose, 1 cc. (15 minims).

**Preparation.**—Chenopodium Oil Capsules, N.F.

#### PHYTOLACCACEÆ (POKE FAMILY)

A family of apetalous trees, shrubs, or woody herbs chiefly of tropical and subtropical climes with alternate entire leaves, and flowers resembling those of the goosefoot family (*Chenopodiaceæ*), but differing in having the gynœcium composed of many carpels united in a ring, and forming a berry in fruit. The genus *Phytolacca* is the sole representative in the United States.

#### PHYTOLACCA (PHYTOLACCA)

**Synonyms.**—Pokeroot, Pigeon Berry, American Nightshade, Scoke, Pocan, Garget Root, Red Ink Plant; *Ger.* Kermesbeerenwurzels; *Fr.* Agouman, Racine de Phytolaque.

**Botanical Origin.**—*Phytolacca americana* Linné. (*Phytolacca decandra* Linné.)

**Part Used.**—The dried root.

**Purity Rubric.**—It contains more than 5 per cent. of its attached stem-bases and not more than 2 per cent. of foreign organic matter and yields not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—E. North America, in waste places. Naturalized in southern Europe and West Indies.

**Plant.**—A smooth perennial herb. The underground portion consists of a much-branched, fleshy root system. From the crown of the tap root arise one or more smooth, purplish-green, aerial stems that may attain a height of 2 to 2.5 m. The leaves are alternate, petiolate, entire, smooth, ovate, and acute at both summit and base. The inflorescences consist of racemes of greenish-white flowers. Each flower has 5 rounded, white sepals, 10 stamens and 10 short, green carpels arranged in a ring. The fruit is a compound berry composed of 10 ripened carpels and of a dark purple color when fully mature. Each matured carpel possesses a single lens-shaped black seed. The young tender shoots of Poke are edible. The leaves and roots have frequently been employed to adulterate Belladonna Leaves and Belladonna Root. The berries are poisonous.

**Production and Commerce.**—The root system is dug up in autumn. After the rootlets have been cut off, it is washed and the fleshy roots are then cut into transverse, longitudinal and oblique slices and dried. The thinner roots are generally cut into segments before drying. The commercial supplies are obtained largely from Michigan, Indiana, North Carolina and Virginia.

**Description.**—In nearly cylindrical segments or short fusiform roots (rarely), for the most part in transverse, longitudinal or oblique, often irregularly broken, slices; externally bark weak brown to weak yellowish-orange, incompletely annulate and longitudinally or spirally wrinkled; texture fibrous; fracture fibrous; inner surface grayish to light brown, showing alternating circular zones of fibrovascular tissue and parenchyma, the latter being much retracted; odor slight; taste at first slightly sweet, then very acrid.

**Microscopical Characteristics.**—Transverse sections of the root are characterized by the presence of suberized epidermis or up to 8 layers of cork, a narrow secondary cortex of parenchyma cells containing starch or raphides of calcium oxalate or microcrystals; several concentric zones of open collateral fibrovascular bundles each of which alternates with a narrower zone of interstitial parenchyma, the bundles of each zone separated by broad pericyclic rays, whose cells contain either short raphides of calcium oxalate, starch or crystal sand. Longitudinal-radial sections of thick roots exhibit tracheæ with elongated and slit-like bordered pores, and with characteristic diamond-shaped bordered pores.

Reticulate and scalariform or reticulo-scalariform tracheids as well as wood fibers with oblique slits will also be observed. See Figs. under Belladonna Root.



FIG. 134.—*Phytolacca decandra*.

**Powdered Drug.**—Light yellowish-brown to weak yellow; sternutatory; calcium oxalate in raphides from 15 to 50 $\mu$  long; also micro-crystals (crystal sand), often filling up the cavities of certain cells; starch grains simple or 2- to 3-compound, the individual grains up to 35 $\mu$  in diameter and with a distinct excentric hilum; lignified sclerenchyma fibers with thin walls and oblique slits; tracheæ with elongated, slit-like, bordered pores or with diamond-shaped bordered pores and tracheids with reticulate, pitted or scalariform or reticulo-scalariform markings; fragments of parenchyma and cork.

**Constituents.**—A bitter saponin-like *glycoside* with an irritant and emetic action, free formic acid, 10 per cent. of a non-reducing sugar, a *resin-like substance* which acts as a central depressant, phytolaccic acid, starch, calcium oxalate, etc.

**Uses.**—Poke root has been used in the form of its fluidextract or as a resinoid (phytolaccin) as an "alterative" in chronic rheumatism and as an emetic.

**Average Dose.**—Emetic, 1 Gm. (15 grains); "Alterative," 0.1 Gm. (1½ grains).

**Preparation.**—Fluidextractum *Phytolacæ* N.F. VII, 0.1 cc. to 1 cc.

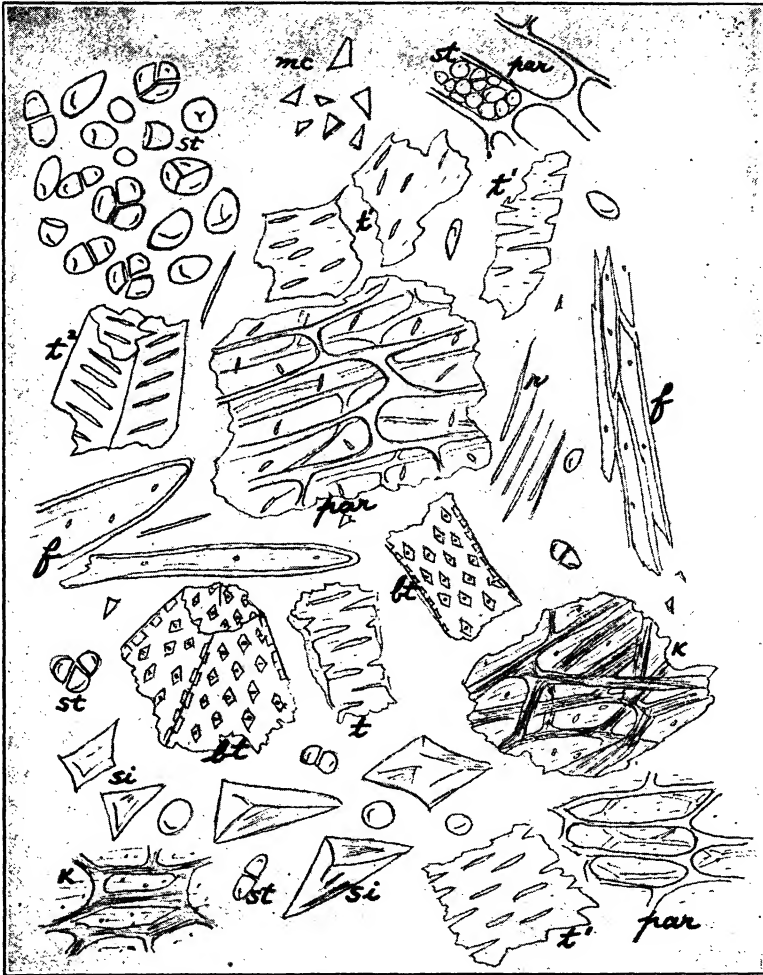


FIG. 135.—Powdered Poke Root. *st*, starch; *mc*, micro-crystals; *par*, ordinary parenchyma; *r*, raphides of calcium oxalate; *t* and *t'* pitted and reticulate tracheae; *t²*, scalariform tracheae; *bt*, bordered pored tracheae; *f*, sclerenchyma fibers; *k*, cork; *si*, silica from adhering soil. (Drawing by H. W. Youngken, Jr.)

#### MAGNOLIACEÆ (MAGNOLIA FAMILY)

Trees and shrubs having alternate leaves and single large hypogynous flowers with calyx and corolla colored alike. Sepals and petals deciduous; stamens numerous with long 2-celled anthers. Carpels numerous, 1-celled and usually spirally arranged on an elongated axis. Bark aromatic and bitter. Fruit a collection of follicles dehiscing dorsally. Seeds albuminous with oily endosperm and minute embryo.

## ILLCIUM (ILLCIUM)

**Synonyms.**—Star Anise, Chinese Star Anise, Fructus Anisi Stellati; *Ger.* Sternanis; *Fr.* Anise étoilé, Badiane.

**Botanical Origin.**—*Illicium verum* Hooker filius.

**Part Used.**—The dried ripe fruit.

**Habitat.**—In mountainous districts of southeastern Asia.

**Plant.**—An evergreen tree growing to the height of 4 to 6 m. The leaves are entire, lanceolate, pellucid-punctate with acute apices. The flowers are greenish-yellow. The fruit consists of 6 to 8 dark brown, woody follicles arranged around a central axis, each containing a compressed-ovoid, shiny, brown seed.

**Production and Commerce.**—Most of the fruits are gathered from trees growing wild as well as cultivated in the Chinese provinces of Kwantung, Kwangsi and Yunnan, in Tong-king, French Indo-China, and in the island of Hainan. Cultivation of the plant is practised extensively in mountainous regions of French Indo-China, Southwestern China, Japan, the Philippines and Jamaica. The fruits are picked just before maturity by natives who use bamboo ladders. Most of the drug is used for the production of volatile oil. In fact the most of the commercial oil of anise on the market consists of oil of star anise. This is distilled from the fresh fruits in primitive iron stills. The greater bulk of the crude drug and the oil used in the United States comes from southern China, being exported from Hong-Kong and Hai-fong in lead canisters.

**Description.**—The fruit is formed of 6 to 8 (rarely 7 to 9) one-seeded, boat-shaped, woody follicles arranged in a radiate whorl around a short central column which proceeds from a short pedicel. The latter is curved near the fruit. The follicles are usually of unequal length, (usually from 12 to 17 mm.), broadly ovate, laterally compressed, the distal portion prolonged to a blunt, nearly straight beak which is not turned upward. Their outer surface is reddish-brown. Their inner surface is pale yellowish-brown and shiny. The seed is compressed-ovoid, shiny, smooth and brown, showing a raphe on the edge. The odor and taste are aromatic, anise-like.

**Powdered Drug.**—Reddish-brown. Column-shaped, irregularly branching and isodiametric stone cells with thick walls and branching pore canals; sclerenchyma fibers, elongated, thick-walled with simple to slightly branched pores; deep reddish-brown parenchyma of mesocarp; polygonal thin-walled cells of endosperm containing oil globules and aleurone grains, the latter  $10\mu$  to  $25\mu$  in diameter and containing a large phytoalbumin and a number of globoids; fragments of epidermis of pericarp, the cells of which have thickened, porous outer walls.

**Constituents.**—*Volatile oil* (2.5 to 5 per cent.) for the most part composed of *anethol* but also containing *l*-phellandrene, *d*-pinene, hydroquinone-ethylether and methyl chavicol; anisic, shikimminic and protocatechuic acids, fixed oil, protein, etc.

**Uses.**—Flavoring agent, stimulant, carminative.

**Dose.**—1 Gm. (15 grains).

**Adulterant.**—Fruits of *Illicium religiosum* Siebold, known commercially as **Shikimmi** fruits or **Japanese Star Anise**, have occasionally been found admixed with Chinese Star Anise. These are very poisonous. They possess a volatile oil containing *eugenol*, *safrol* and *shikimmin*; a poisonous crystalline principle insoluble in water but soluble in alcohol called shikimmin or *sikimin* and a toxic

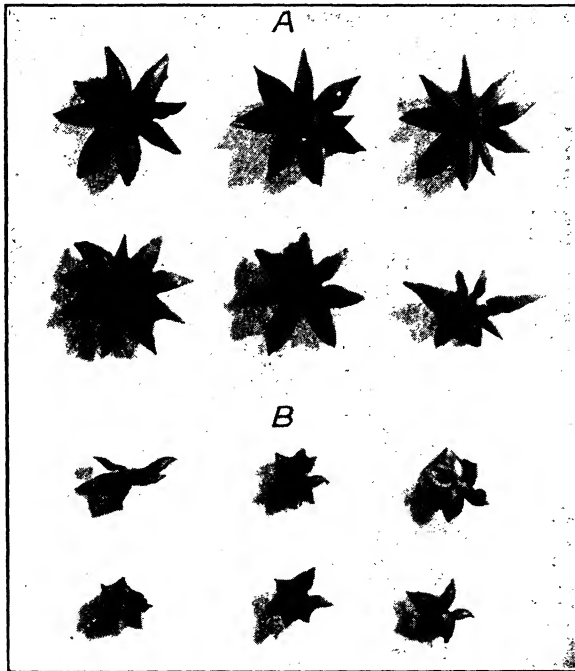


FIG. 136.—Chinese star anise (A); Japanese star anise (B).  $\times \frac{1}{2}$ .

alkaloid known as *skimmianin*. The chief diagnostic differences between Chinese and Japanese Star Anise will be noted in the following table:

CHINESE STAR ANISE	JAPANESE STAR ANISE
1. Follicles with acute summit tapering to blunt, nearly straight beak.	1. Follicles for most part smaller than Chinese Anise, with acuminate summit tapering to short, upward curved beak.
2. Irregularly branching stone cells in central axis.	2. Stone cells of central axis somewhat rounded.
3. Aleurone grains of seed endosperm contain one large phytoalbumin and usually a number of globoids.	3. Aleurone grains contain 2 or 3 prismatic phytoalbumins and 2 or 3 globoids.
4. Powder becomes blood red when boiled in dilute potassium hydroxide.	4. Powder becomes yellowish-brown when similarly treated.
5. Odor resembling Anisum.	5. Odor resembling Sassafras or Cajuput.
6. Taste aromatic, like Anisum.	6. Taste aromatic, bitter and camphor-like.

## ANISE OIL U.S.P. (OLEUM ANISI)

**Synonyms.**—Oleum Illicii, Oleum Badiani; *Ger.* Anisol; *Fr.* Essence d'Anis.

**Definition.**—The volatile oil distilled with steam from the dried ripe fruit of *Pimpinella Anisum* L. (Fam. *Umbelliferae*) or from the dried ripe fruit of *Illicium verum* Hooker filius (Fam. *Magnoliaceae*).

**Commercial.**—Oil of Star-anise is imported from China and Hong-Kong, oil of *P. Anisum* from India.

**Description.**—Oil of anise is a colorless or pale yellow, strongly refractive liquid having the characteristic odor and taste of anise; sp. gr. 0.978 to 0.988, opt. rot. from  $+1^{\circ}$  to  $-2^{\circ}$  in a 100 mm. tube at  $25^{\circ}\text{C}$ .; ref. ind. 1.5530 to 1.5600 at  $20^{\circ}\text{C}$ . It is soluble without cloudiness in 3 volumes of 90 per cent. alcohol.

**Constituents.**—Chiefly *anethol* but also small quantities of *phellandrene*, pinene, hydroquinone-ethyl-ether and methyl chavicol.

**Uses.**—Stimulant, carminative, expectorant; in colic, etc., and as a flavoring agent.

**Average Dose.**—0.1 cc. ( $1\frac{1}{2}$  minims).

**Preparations.**—In U.S.P.—Anise Water; Compound Orange Spirit; Camphorated Opium Tincture, 4 cc.; Glycyrrhiza Syrup. In N.F.—Anise Spirit, 1 cc.

**Anethole N.F.**,  $\text{C}_6\text{H}_4\text{C}_3\text{H}_5\text{OCH}_3$ , is parapropenyl anisole. It is the chief constituent of oils of anise and fennel and usually obtained from these by fractionating, chilling, and crystallizing. A colorless or faintly yellow liquid at or above  $23^{\circ}\text{C}$ ., possessing a sweet taste and aromatic odor and solidifying to a white, crystalline mass at from  $20^{\circ}$  to  $21^{\circ}\text{C}$ . **Av. Dose.**—0.1 cc. ( $1\frac{1}{2}$  minims). It enters into Anisated Ammonia Spirit, N.F., Compound Cardamom Spirit, N.F. and Elm Troches.

## MYRISTICACEÆ (NUTMEG FAMILY)

A family of tropical, aromatic and diœcious trees and shrubs having entire, alternate, petiolate, evergreen leaves, small regular flowers, and capsular fruits. The seeds are albuminous and covered by a fleshy lacinate arillode. Secretory sacs with suberized walls and containing a yellowish, brownish or red oil are scattered throughout the plants. The hairs are stellate. Calcium oxalate has been found in a number of the plants investigated in the form of acicular crystals or aggregates of these.

## MYRISTICA U.S.P. (MYRISTICA)

**Synonyms.**—*Nutmeg*; Round Nutmeg, *Ger.* Myristicasamen; *Fr.* Muscade.

**Botanical Origin.**—*Myristica fragrans* Houttuyn.

**Part Used.**—The dried ripe seed, deprived of its seed coat and arillode and with or without a thin coating of lime.

**Standard of Assay.**—It yields not less than 25 per cent. of non-volatile, ether-soluble extractive.

**Ash.**—Not more than 0.5 per cent of acid-insoluble ash.

**Habitat.**—Molucca Islands. Cultivated in tropical lands.

**Plant.**—An evergreen tree growing to the height of 25 to 50 feet. Its leaves are coriaceous, dark green, entire, oblong-ovate to ovate-lanceolate in outline with acute apex and base. Its pistillate flowers are small, yellow, and axillary. Its fruit is a yellow, nearly globular, tough, fleshy, 2-valved, longitudinally grooved capsule which contains a single ovoid seed. The seed is closely surrounded and almost completely covered by a fleshy, irregularly slit arillode.

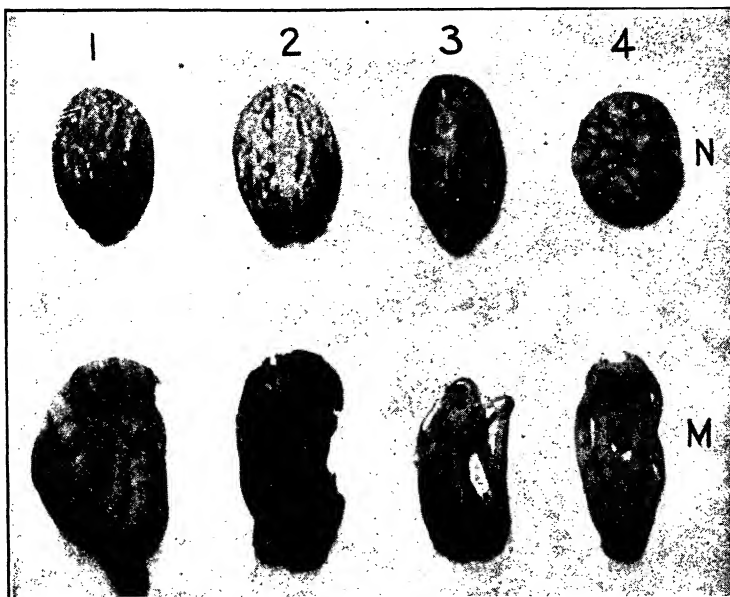


FIG. 137.—*N*(1, 2, 3, 4) Nutmeg. *M*, Mace.  $\times \frac{1}{4}$ . 1, reticulately furrowed surface. 2, reticulately furrowed surface with lengthwise groove, 3, longitudinally cut surface, 4, transversely cut surface. In 3 and 4 note the darker marginal perisperm extending into the lighter colored endosperm, forming ruminant albumen and giving the mottled appearance to the cut surface.

**Production and Commerce.**—Nutmeg trees grow wild in the Dutch Banda and adjacent islands of the East Indies where the soil is light and the climate moist. They are cultivated in the Banda Islands, Java, Sumatra, Penang, Ceylon, Malacca and the West Indies. The trees bear fruit when 8 or 9 years old and yield annually for about 60 years. The fruit is collected in Eastern countries, after it has split open, by means of a hook fastened to a long pole or by hand. In Grenada the fruits are allowed to fall to the ground. The orange-yellow pericarp (fruit wall) is removed and the scarlet arillus ("mace") carefully stripped off, flattened and dried. The seeds are then taken to the drying house and placed on frames where they are exposed to a gentle heat for two months, being turned every 2 or 3 days. As soon as the kernels rattle within their shells, the shells (seed coats) are broken with a mallet, the kernels removed and assorted, and the best often coated with milk of lime or powdered



slaked lime to prevent insect attacks. In Penang and Singapore the kernels are unlimed. Inferior kernels are employed for expressing the oil.

Nutmegs have been imported into the United States from the Netherlands East Indies and from British Malaya, Trinidad, and from the British and Netherlands West Indies. The importations during 1945 were 3,248,150 lbs. all of which came from the Leeward Islands and Trinidad. East Indian nutmegs are frequently limed, the West Indian not limed. Shrivelled and defective nutmegs and nutmegs in the shell are imported for distillation of the oil. East Indian nutmegs are shipped to this country from the ports of Padang, Batavia, Penang, Singapore and Surabaya. West Indian nutmegs are shipped from Grenada and Trinidad. Both kinds are imported in bags. Approximately 50 per cent of our normal supply comes from Grenada and 40 per cent. from Netherland Indies and British Malaya. Moldy and insect-infested material is the chief cause of inferiority.

**Physical Characteristics.**—Globular, ovoid or ellipsoidal, 20 to 30 mm. in length, 15 to 24 mm. in diameter; externally light to dark brown, usually whitish on account of the lime coating, reticulately furrowed and deeply grooved on one side, the groove indicating the position of the raphe; at one end showing a white projection in the center of which is the micropyle; when cut, the exposed surfaces have a mottled appearance because of the ruminate albumen (dark brown outer perisperm penetrating by numerous branches into the light brown endosperm); odor strongly aromatic; taste warmly aromatic.

**Powdered Drug.**—Reddish-brown. Under the microscope it shows fragments of perisperm composed of small, thin-walled parenchyma cells with brown pigment and few spiral ducts imbedded in which are large reservoirs with volatile oil contents; fragments of the endosperm, composed of polygonal-shaped parenchyma cells, filled with starch and aleurone grains and occasionally brown pigment; starch grains simple or 2- to 20-compound, the individual grains being spheroidal, polygonal or plano-convex, from  $3\mu$  to  $22\mu$  in diameter with distinct hilum; aleurone grains with large phytoglobulin. The powder obtained from limed nutmegs, when examined in 25 per cent. sulphuric acid, shows small acicular or short rod-shaped crystals of calcium sulfate which have separated.

**Constituents.**—Up to 40 per cent. of a *fixed oil* containing *trimyristin*, oleic acid, linolenic acid, etc.; up to about 10 per cent. of *volatile oil* containing *myristicin* ( $C_{11}H_{12}O_3$ ), a narcotic principle, (4 per cent.), pinene and camphene (80 per cent.), dipentene (8 per cent.), safrol (0.6 per cent.), alcohols (about 6 per cent.) and traces of eugenol and isoeugenol; starch and proteins.

In excessive amounts both nutmeg and its volatile oil are poisonous, producing mydriasis and stupor.

**Uses.**—Nutmegs are used as a spice and medicinally as a stimulant and carminative, also as a source of oil of nutmeg and expressed oil of nutmeg or nutmeg butter.

**Average Dose.**—0.5 Gm. (8 grains); of oil of nutmeg, 0.03 cc. ( $\frac{1}{2}$  minim).

**Preparations.**—Compound Lavender Tincture, U.S.P., 2 cc. (30 minims); Aromatic Powder, N.F., 1 Gm. (15 grains); Aromatic Chalk Powder, N.F., 2 Gm. (30 grains).

**Substitutes.**—1. *Papua* or *Macassar* nutmegs obtained from *Myristica argentea* Warburg, a tree of New Guinea. These are longer (about 3.5 cm.), narrower and less aromatic than the genuine with a feeble odor and disagreeable, acrid taste. Imported here in large amounts.

2. *Bombay* nutmegs from *Myristica malabarica* Lamarck, which are ellipsoidally-elongate and entirely devoid of odor.

**Adulterants.**—The powdered drug has been adulterated with exhausted nutmeg, corn meal, curcuma, powdered beans, ground olive pits and ground coconut shells.

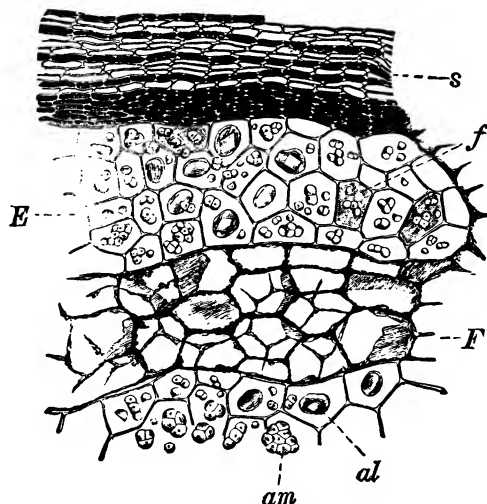


FIG. 138.—Cross section of the outer region of kernel of *Myristica fragrans* (Nutmeg),  $\times 160$ . *s* primary or outer perisperm; *F* secondary perisperm (an ingrowth of the primary perisperm into the endosperm region); *E* endosperm with *am* starch grains, *al* aleurone grains and *f* pigment cells. (From Winton's "Microscopy of Vegetable Foods," J. Wiley & Sons, Inc., after Moeller.)

**Nutmeg Butter** or Expressed Oil of Nutmeg is an orange-red to reddish-brown soft solid with a nutmeg odor and taste. It consists chiefly of the fixed oil of nutmeg containing trimyristin with a small amount of volatile oil. Used externally in liniments and ointments as a counterirritant.

#### MACIS (MACE)

**Synonyms.**—True Mace; *Fr.* Fleur de muscade; *Ger.* Muskatblüthe.

**Botanical Origin.**—*Myristica fragrans* Houttuyn.

**Part Used.**—The dried arillode of the seed.

**Standard of Purity.**—Not more than 3 per cent. total ash, 0.5 per cent. acid-insoluble ash, not more than 10 per cent. of crude fiber and not less than 20 per cent. and not more than 30 per cent. of non-volatile ether extract (U.S. Dep. Agr., S.R.A. F.D., No. 2, Rev. 5, 1936).

**Production and Commerce.**—The scarlet arillode is removed by hand or with a knife from the nutmeg seed. When entire it forms "double blade" mace, but if removed in two pieces, it is called "single blade" mace. It is

flattened by treading or pressing between boards and dried in the sun for several days when it becomes yellow or orange colored and brittle. It is then graded according to quality and color as No. 1 and No. 2. Upwards of 1,000,000 pounds of Mace are imported annually into this country from the East and

West Indies and British Malaya. It is shipped in cases containing from 110 to 363½ lbs., and in bags. East Indian mace comes either direct from Amboyna, Banda, Padang, Papua, Batavia, Singapore and Surabaya. West Indian mace is shipped from Grenada and Trinidad.

**Description.**—It occurs in buff to brownish-orange colored, oily, narrow bands, 25 mm. or more in length, somewhat branched and lobed above, united into broader bands below; odor fragrant; taste warmly aromatic. (Fig. 137M.)

**Histology.**—Transverse sections cut through the middle or upper part of Mace show the following microscopic structures:

1. *Outer epidermis* of tangentially-elongated cells with thick walls and very thick outer cuticle.

2. *Fundamental parenchyma* of thin-walled cells containing numerous small amyloextrin granules of various shapes. These can be best seen in sections first cleared with ether or petroleum benzin. Through this zone fibrovascular bundles course. Large oil cells are found scattered among the parenchyma cells.

3. *Inner epidermis* similar to the outer epidermis.

**Powdered Drug.**—Orange buff to orange brown and showing in microscopic mounts made in water the following: Elongated epidermal cells, fragments of parenchyma cells with small amyloextrin granules which take a red color with iodine, and large secretion sacs containing yellow oil.

**Constituents.**—From 7 to 14 per cent. of *volatile oil* containing myristicin, myristic acid, pinene, dipentene, myristicol and phenols; fixed oil, resin, mucilage, etc.

**Uses.**—Flavoring agent, stimulant, carminative and aromatic. Its chief uses are in the flavoring of cakes and other bakery products, meat and fish dishes, preserves and pickles, in the manufacture of Worcestershire sauce, Yorkshire relish, Cambridge sausage, frankfurters, mustard sauce, etc. It is a constituent of a number of ground spice formulas such as mincemeat spice, sausage spice, etc.

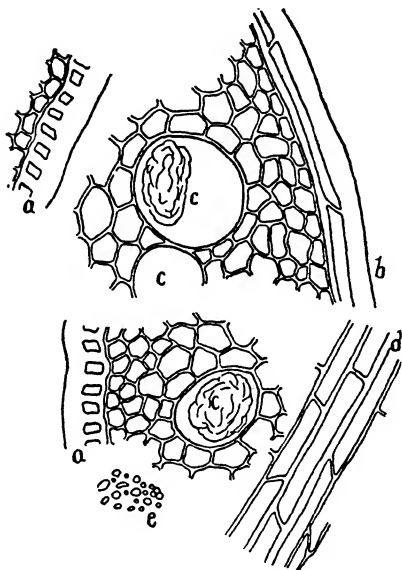


FIG. 139.—Bombay or False Mace. *a*, transverse view of epidermis and underlying parenchyma with resin-containing cell (*c*); *b*, longitudinal view of epidermis and parenchyma; *c*, resin cells; *d*, surface section (vertical) view of the epidermal cells; *e*, amyloextrin granules. This is the most common adulterant of true mace. (After Schneider.)

**Dose.**—0.5 Gm. (8 grains).

**Adulterants.**—1. Bombay Mace consisting of the arillode of *Myristica malabarica* Lam., a tree native to India. Whole Bombay Mace is more elongated than true mace, up to about 5 cm. in length with numerous narrow branches, dark reddish brown or red, odorless and tasteless. 2. Ground cereals and ground Bombay mace have occurred in ground "true mace."

**Adulterant of Powdered Mace:** The ground arillode of *Myristica malabarica* Lam., commonly called Bombay Mace. The distinctions between genuine powdered Mace and Bombay Mace are as follows:

**POWDERED TRUE MACE**

Orange buff to orange-brown.

Taste aromatic.

Secretion sacs contain a yellowish oil, not greatly changed in color by addition of an alkali.

HCl gives no greenish color.

If potassium chromate T.S. is added to an alcoholic solution of Mace (1 in 10), the precipitate formed is yellow and does not change to red on standing, nor does the solution develop a red coloration.

Oil cells pale yellow after treatment with caustic alkali.

Amylodextrin granules up to  $12\mu$  in length.

**POWDERED BOMBAY MACE**

Yellowish-brown to deep brown.

Taste non-aromatic.

Secretion sacs contain an orange-red resinous substance which is dissolved by alkalis forming a blood red liquid.

HCl produces greenish color.

Similar treatment of an alcoholic solution (1 in 10) of Bombay Mace or true Mace adulterated with the latter results in a yellow precipitate changing soon to red and the solution becomes red.

Oil cells showing blood-red liquid after treatment with caustic alkali.

Amylodextrin granules attaining a greater length.

**MYRISTICA OIL U.S.P. (OLEUM MYRISTICÆ)**

**Synonyms.**—*Nutmeg Oil, East Indian Nutmeg Oil, West Indian Nutmeg Oil.*  
*Ger.* Aetherisches Muskatöl; *Fr.* Essence de Muscade.

**Definition.**—The volatile oil distilled with steam from the dried kernels of the ripe seed of *Myristica fragrans* Houlttuyn (Fam. *Myristicaceæ*).

**Description.**—A colorless or pale yellow liquid possessing the characteristic odor and taste of nutmeg; sp. gr. 0.880 to 0.910 for E. Ind. Oil and 0.854 — 0.880 for W. Ind. O. at 25°C.; opt. rot. from +10° to +30° for E. Ind. O. and +30° to +50° for W. Ind. O. in a 100 mm. tube at 25°C.; ref. ind., 1.4740 — 1.4880 for E. Ind. O. and 1.4690 — 1.4760 for W. Ind. O. at 20°C.

**Constituents.**—*Pinene* and *camphene* (80 per cent.) *dipentene* (8 per cent.) a crystalline toxic substance termed *myristicin* (4 per cent.), *eugenol* and *iso-eugenol* (0.2 per cent.), *safrol* (0.6 per cent.) and alcohols (about 6 per cent.).

**Uses.**—Flavoring agent and carminative.

**Average Dose** (unof.).—0.03 cc. ( $\frac{1}{2}$  minim).

**Preparations.**—Aromatic Ammonia Spirit (*Spiritus Ammoniae Aromaticus*), U.S.P. 2 cc. (30 minims); Pepsin and Rennin Elixir, N.F., 8 cc. (2 fld. dr.).

**RANUNCULACEÆ (CROWFOOT FAMILY)**

Herbs (Buttercups, Aconites, etc.), rarely shrubs (*Clematis*), with acrid, poisonous, watery juices and with alternate, rarely opposite, simple, rarely compound, exstipulate leaves. Flowers pentamerous, regular to irregular, incomplete to complete, aposepalous and apopetalous. Sepals 5—rarely more or

less—green to petaloid, regular, passing to irregular (Larkspur, Monkshood) Petals none or 5, regular to rarely irregular, often nectariferous and with nectariferous petals often variously transformed. Stamens indefinite, hypogynous. Pistil of many to few apocarpous carpels, each carpel with one to several ovules. Fruit a collection of achenes (*Ranunculus*, *Anemonella*), or a collection of follicles (Columbine, Larkspur, Peony) or rarely a berry as in Baneberry (*Actæa*). Seeds albuminous. Many of the species contain alkaloids.

Among the histological peculiarities of this family the following might be mentioned as of pharmacognic importance: In many plants of the group, the xylem, as viewed in cross sections, has the form of a V or U. There is a marked tendency to the formation of sclerenchyma in the pericycle. The tracheæ show mostly simple perforations. Cork arises internally. Fibrovascular bundles are formed in two or more circles in stems of species of *Cimicifuga* and *Actæa*. The epidermis of the leaves and young stems often produces nonglandular and glandular hairs, the latter being unicellular. Crystals of calcium oxalate are not frequent. The tuberous roots of a number of Indian species of *Aconitum* and of some specimens of *A. Napellus* exhibit anomalous structure.

#### ACONITE N.F. (ACONITUM)

**Synonyms.**—*Monkshood*, *Aconite Root*, *Aconiti tuber P.I.*, *Aconite Tuber*, *Wolfsbane*, *Cuckoo's Cap*, *Blue Rocket*, *Friar's Cap*, *Jacob's Chariot*; *Fr.* Coqueluchon; *Ger.* Aconitknollen, Sturmhut, Eisenhut.

**Botanical Origin.**—*Aconitum Napellus* Linné.

**Part Used.**—The dried tuberous root.

**Limit of Impurities.**—5 per cent. of Aconite stems and 2 per cent. of foreign organic matter, other than stems.

**Standard of Assay.**—This drug is standardized biologically on guinea pigs. The potency of Aconite shall be such that 0.1 Gm. of it, when extracted and assayed as directed under Aconite Tincture, shall possess an activity equivalent to not less than 0.150 mg. of Reference Aconitine.

**Habitat.**—Mountainous districts of Europe and Asia. *Aconitum Napellus* L. var. *delphinifolium* Seringe is native to wet places from Alaska to British Columbia.

**Plants.**—*Aconitum Napellus* is a large group consisting of numerous subspecies, varieties, clones and forms. Perennial herbs attaining the height of from 0.7 to 1.5 m. The underground portion consists of a fusiform, parent, tuberous root from which arise one or more lateral shoots, each forming a conical daughter tuberous root. The leaves are alternate, long stalked, with blades palmately cut into 5 or 3 segments which are in turn divided into narrow segments. The inflorescence is a terminal raceme or a panicle of racemes of violet-blue flowers. The bracts are lanceolate, there being two beneath each pedicelled flower. The sepals are 5, bluish-purple, the upper one helmet-shaped, laterally compressed, the 2 lateral ones blunt and ovate, the two lower oblong-lanceolate. The petals vary from 2–8 and are hammer-like, the 2 posterior ones being conspicuous, nectariferous and covered by the hood of the posterior

sepal. The stamens are numerous and hypogynous. There are 3 or 4 carpels, with bilobed stigmas. The fruit consists of 3 to 4 beaked follicles containing numerous angular, wrinkled and acrid seeds. Spark's variety of *A. Napellus* is a clone grown as an ornamental herb.



FIG. 140.—*Aconitum Napellus*. Note the palmately 3- to 5-cut leaf blades and the terminal raceme of flowers. In each flower, the posterior sepal is helmet- or hood-shaped and, in the incompletely expanded condition, arches over the rest of the flower. Hence, the common names, "Monkshood" and "Friar's Cap," assigned to the plant because of fancied resemblance.

**Production and Commerce.**—Aconite is largely collected from plants growing wild in cool regions of Spain, France, Switzerland, Germany and Russia. It may be propagated from seeds or by divisions of roots. The latter method is preferable in localities where more than one species abounds, since hybridization is avoided. If seeds are employed they should be planted as soon as possible after they are gathered from the plants for, if allowed to completely dry, they lose in their power of germination and are mostly non-viable after a year's storage. Elevated situations, some shade, cool climate and well-drained

gravelly loam are ideal conditions for a good crop. The tuberous roots are dug in autumn preferably after the stems have perished, washed, freed from the



FIG. 141.—*Aconitum Napellus* var. *Sparks*. Terminal portion of stem showing panicle of racemes. On right, a foliage leaf.

rootlets and carefully dried. The smaller roots can well be planted for another crop. The commercial supplies have been imported largely from Germany, Italy, Spain and France. During 1946, 38,582 pounds of aconite were imported into this country from Europe.

**Description.**—The tuberous roots occur either singly or in clusters of 2 (or more), the younger smoother root or roots being connected with the older deeply wrinkled root by means of a side branch or branches. Each root is somewhat conical from 4 to 10 cm. in length and from 1 to 3.5 cm. in width at the crown; externally weak brown to moderate brown, smooth or longitudinally wrinkled, the upper end with a bud or remains of bud scales (young daughter roots) or



FIG. 142.—Root system of *Aconitum Fischeri*, Reich., showing parent tuberous root on right joined to daughter tuberous root on left by a side branch. Note the long tapering processes of roots, the aerial stem issuing from daughter root which bears the leaves and flowers of the current season, also the young tuberous root of the following season borne on a side branch arising from the daughter tuberous root.

stem scars or basal portions of stems (older shriveled roots), the other external portions with numerous rootlet scars or short rootlets; fracture short, horny or mealy; internally, old roots are brownish while young roots are yellowish white, exhibiting a 5- to 8-angled cambium with a small fibrovascular bundle in each angle; odor slight; taste sweet, becoming acrid, developing a tingling sensation, followed by numbness.

**Histology and Development.**—Near the distal end of the process at the tip of the long tapering process of the root, cross sections show a diarch radial bundle. Further along this process the radial bundles become successively tetrarch, pentarch, and occasionally octarch as shown by Neuber and Tschirch.





FIG. 143.—Tuberous roots of *Aconitum Napellus*. Note that several of these show parent and daughter tubers still joined together.  $\times \frac{1}{2}$ .

Outside of the radial bundle is a pericambium, an endodermis, a comparatively broad primary cortex and an epidermis.

Toward the basal portion of the process cambium formation takes place on the inner face of each primary phloem patch and outer face of each xylem patch which cuts off groups of secondary leptome and parenchyma on its outer face, pushing out the primary leptome. It next cuts off secondary xylem on its inner face. A pith developed from the plerome is seen at the center. This at first is only a few cells in diameter.

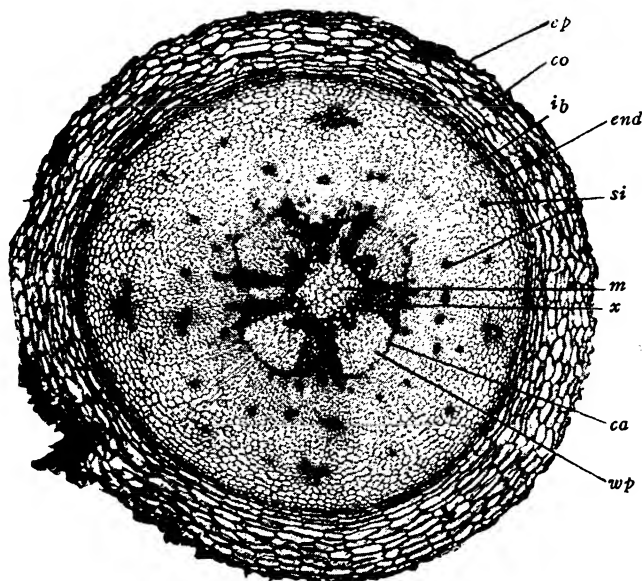


FIG. 144.—Transverse section of daughter tuberous root of *Aconitum Napellus*, Spark's variety, cut a short distance above the tapering process through portion 2.2 mm. in diameter. Photomicrograph  $\times 37$ . *ep*, epidermis; *co*, primary cortex; *end*, endodermis; *ib*, inner bark; *si*, sieve tissue; *ca*, cambium; *wp*, wood parenchyma; *x*, tracheary tissue of xylem; *m*, pith.

By the time the root is 2 mm. in diameter, there is to be noted, passing from periphery to center:

1. An *epidermis* of small, somewhat hemispherical shaped cells with their outer walls suberized and occasionally elongated into root hairs or papillæ.
2. A *primary cortex* (*primary bark*) of 9 to 10 layers of cortical parenchyma, the cells containing abundant starch.
3. An *endodermis* of endodermal cells with suberized walls, the outer walls being prominently thickened.
4. A comparatively broad secondary *inner bark* of 20 to 30 layers of cells showing patches of primary sieve tubes in the outer region directly in line with the points of the cambium star. The rest of the structure of this region consists of starch parenchyma, the cells of which are more or less radially arranged in the thicker parts opposite the sinuses of the cambium and also some groups of secondary sieve in the inner region which are surrounded by parenchyma.

5. A sinuous *cambium* line with usually 5 to 7 angles which has already laid down parenchyma and secondary sieve tubes on its outer face and some secondary xylem on its inner face. The amount of secondary xylem is especially pronounced beneath the angles, less so in the sinus regions.

The cambium has also cut off frequently 2 to 4 medullary rays in some of the arm regions of the xylem.

6. A closed arc of *xylem* of stellate shape.

7. A narrow, rounded to oval *pith* of parenchyma cells about the same size as those of the secondary bark. In a series of sections cut at progressive levels, passing upward from this lower region to the base of the root evidences are noted of the adaptation of structure to the function of storage.

The cells of the pith rapidly proliferate and increase in size, so that this region rapidly grows in diameter. The original closed arc of xylem becomes broken by the encroachment of the pith so that ultimately, in the curves of the several pointed cambial star no more early formed xylem exists. This has been pushed to either side and assumes the form of U- or V-shaped strands of tracheary tissue with parenchyma developed in the sinus of the U or V. Pith tissue extends out into the arms of the star. The cambium next forms secondary xylem strands and frequently collateral bundles containing phloem outward and xylem internal in the sinuses, and all along its line cuts off secondary bark tissues on its outer face including secondary sieve and parenchyma tissue. On its inner face it adds to the depth of the tracheary tissues and cuts off medullary-ray cells, making the angles of the star appear 2- to several rayed. Little division of cells occurs in the primary cortex, but gradually some of the parenchyma cells in this region lose their protoplasmic contents and develop lignified walls, becoming stone cells. In many roots examined by the writer, stone cell formation also occurs just within the endodermis, in the outer region of the secondary bark.

Eventually the primary cortex dies from without inward and forms a brown *metaderm*. This sloughs off and together with the endodermis is often absent in sections of old tuberous roots.

A transverse section cut  $\frac{1}{8}$  the distance from tip to crown showed:

1. *Epidermis*, some of the cells of which were filled with air.
2. *Primary cortex*, the cells of which had been more tangentially-elongated than in the former type of section. In this region occurred numerous stone cells of varying shape and size.
3. *Endodermis*, more or less collapsed and somewhat modified as to walls and contents, the walls suberized.
4. *Inner bark*, considerably augmented in width and composed of a broad expanse of starch-parenchyma in which were embedded numerous islets of sieve tissue. The latter were especially noted in line with the points of the star. In the outer region, just beneath the endodermis many stone cells occurred in several roots examined.
5. A wavy, stellate *cambium line* of more usually 6-7 angles with U- to V-shaped open collateral bundles in the angles, some of which were 2- to 4-rayed.

6. A broad stellate *pith* of large-celled starch parenchyma, 1.35 mm. in broadest part. The pith parenchyma cells were averagely 3 times the size of the cells of the secondary bark.

Another section cut through the mid region of the root of *A. Napellus* and 10 mm. in diameter showed the secondary bark up to 1.36 mm. thick. It had decidedly longer pith arms than those in the preceding section and the pith was about twice the diameter. The outer region of the primary cortex (bark)

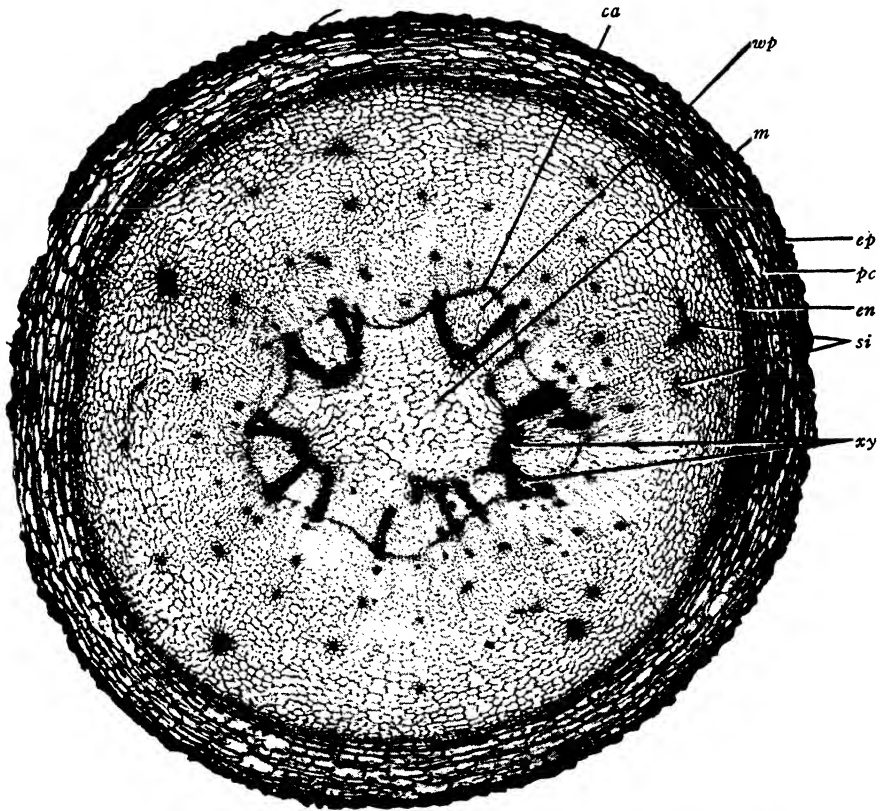


FIG. 145.—Transverse section of daughter tuberous root of *Aconitum Napellus*, Spark's variety, cut slightly below mid-region. Photomicrograph  $\times 25$ . *ep*, epidermis; *pc*, primary cortex; *en*, endodermis; *si*, sieve strands in inner bark; *ca*, cambium; *wp*, wood parenchyma; *xy*, tracheary tissue of xylem; *m*, pith.

showed suberization of the cell walls. This zone represents the "metaderm" of Tschirch.

**Old Parent Root of *Aconitum Napellus*.**—Metaderm formation began at the tip and at  $\frac{1}{8}$  in. from the tip it had extended as far inward as the endodermis.

Passing upward about  $360\mu$  from this point, the metaderm showed evidences of sloughing off. Half way up the metaderm was still present and endodermis indistinct as such. More fissures between layers of metaderm cells were apparent. Near the summit suberization had extended beyond the endodermis and

some sloughing off of this tissue had taken place. It is, accordingly, apparent that centripetal suberization of the parent Aconite tuber takes place, first involving the epidermis, then the outer cortex, next the endodermis, and finally the outer region of the inner or secondary bark. This is accompanied by disintegration of the parenchymatous cells of the old tubers. In some old tubers which I had examined, the metaderm had sloughed off completely as far as the

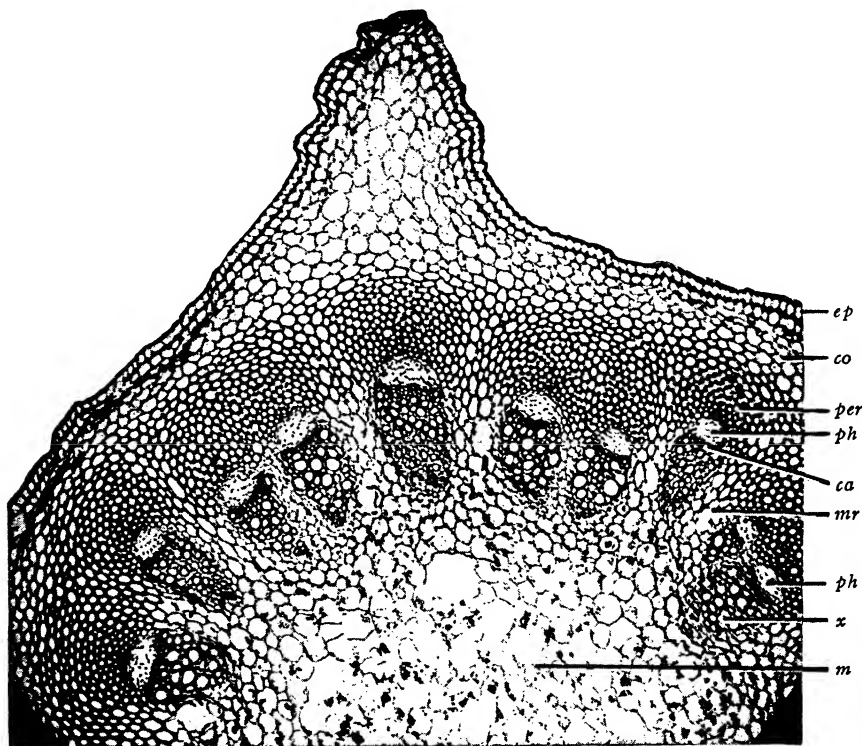


FIG. 146.—Transverse section of dried and macerated stem of *Aconitum Napellus*. Photomicrograph  $\times 37$ . *ep*, epidermis; *co*, cortex; *per*, pericyclic fibers; *ph*, phloem; *ca*, cambium; *x*, xylem; *mr*, medullary ray, *m*, pith.

outer region of the inner bark. These exhibited, passing from periphery toward the center, the following structure:

1. A zone of *suberized* cells, with reddish-brown walls.
2. *Secondary (inner) bark* of enlarged and disintegrated parenchyma and scattered patches of sieve tubes, but no stone cells.
3. A stellate *cambium* of 5–8 arms with open collateral bundles in the points of the star.
4. *Pith* of large, more or less disintegrated parenchyma cells and scattered large air-spaces.

As compared with the daughter tubers, the parent or mother tuber possesses relatively fewer starch grains, in fact a greatly reduced amount of starch.

Longitudinal-radial sections exhibited tracheæ with slit-like pores, bordered pores, reticulate and occasional spiral markings, from 10 to 60 $\mu$  in diameter. The sieve tubes possess horizontal plates.

**Stem of *Aconitum Napellus* L.**—The stem of this plant is upright, smooth and terete, of light green color and fibrous texture. Indried specimens, it tends to become angular-terete in outline, when viewed with a hand lens. Cross sections, when examined microscopically, exhibit (1) an *epidermis* of cubical epidermal cells whose outer walls are mostly convex and cuticularized, (2) a *hypodermis* of cubical to rounded-cubical cells tending to be somewhat collen-

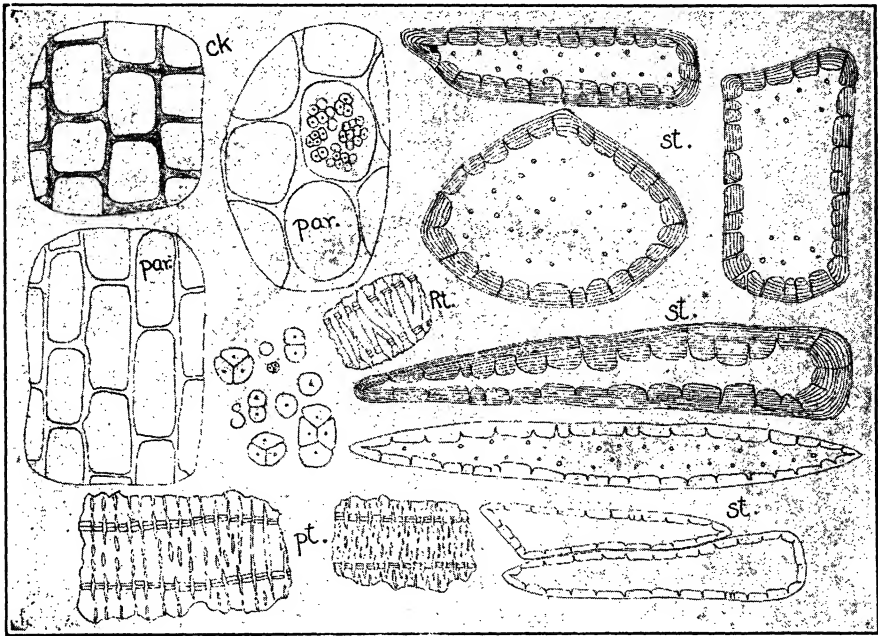


FIG. 147.—Powdered Aconite. *ck*, cork; *par*, parenchyma; *s*, starch grains; *rt*, reticulate trachea; *pt*, pitted trachea; *st*, stone cells. (Drawing by S. Mushlin.)

chymatic and containing chloroplasts, (3) a *primary cortex* of from about 5 to 15 layers of isodiametric parenchyma cells being broadest in the angles, (4) a *pericycle* containing a broad continuous band of lignified pericyclic fibers each of which is polygonal in cross section, (5) an interrupted circle of *open collateral bundles* attached to the inner margin of the pericyclic fiber band, and separated from one another by *medullary rays*, (6) and a central, mostly large-celled pith, which, in the lower part of the stem, becomes somewhat disintegrated in centrifugal manner, leaving a hollow center. Longitudinal sections exhibit a xylem with spiral, simple-pitted, bordered pored and reticulate tracheæ, also wood fibers, many with a lumen considerably broader than the walls and with pointed to obtuse ends, and numerous wood parenchyma cells with broad lumen, beaded walls and numerous pores.

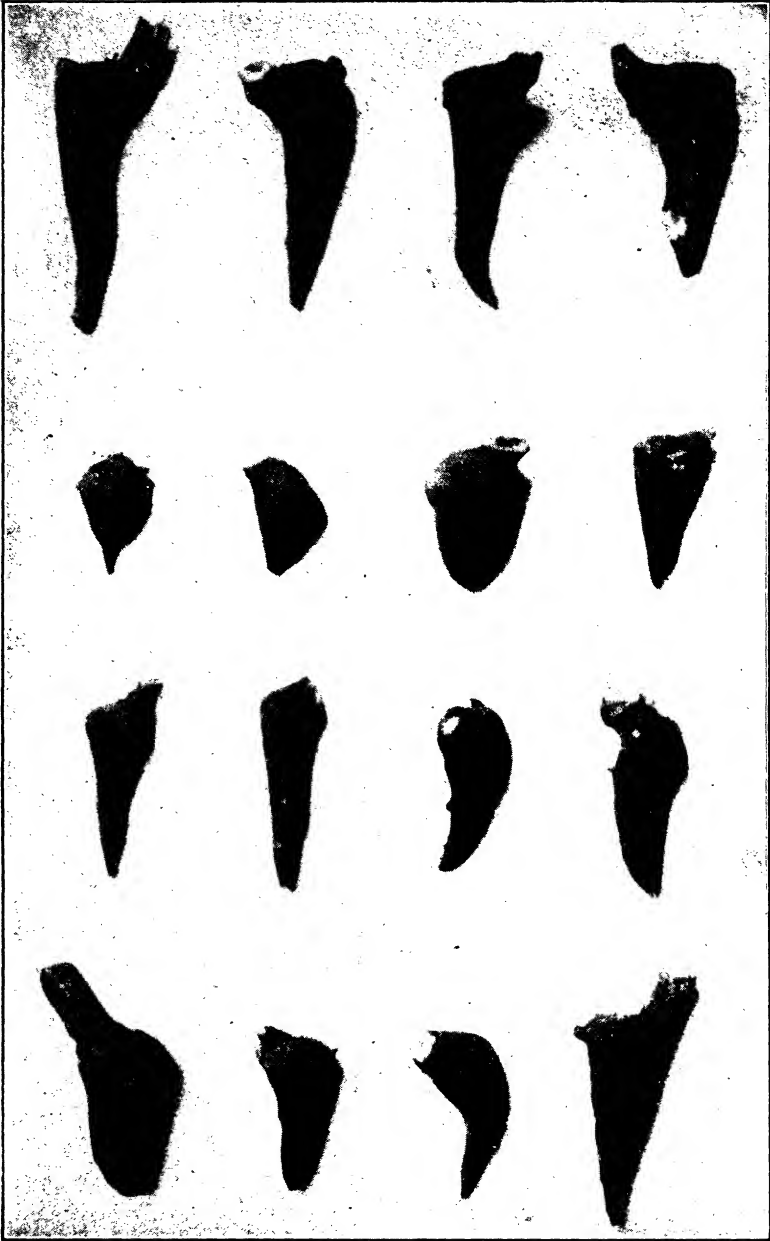


FIG. 148.—Japanese aconite.  $\times \frac{1}{2}$ .

**Powdered Drug.**—Pale brown to weak yellowish orange; starch grains abundant, spherical or plano-convex, single or 2- to 5-compound, the individual grains from  $3\mu$  to  $20\mu$  in diameter and frequently showing a central cleft hilum; stone cells of tabular, rectangular, rhomboidal, ellipsoidal or other shapes, strongly lignified or elongated to fibers up to  $400\mu$  long with porous walls up to  $25\mu$  thick; fragments of brown cork; fragments of parenchyma filled with starch; sclerenchyma fibers from stems few, very long with lignified walls the latter about  $5\mu$  or  $6\mu$  in thickness and showing oblique or transverse slit-like pores; tracheæ for the most part with slit-like, simple pores but spiral, reticulate and border pored tracheæ also present.

**Constituents.**—The crystalline alkaloid *aconitine* ( $C_{34}H_{47}O_{11}N$ ), the amorphous alkaloids *aconine* and *benzaconine* (*napelline*) which are products of the hydrolysis of aconitine; aconitic acid, starch, mannitol and resin. Aconitine is the cardiac irritant alkaloid and occurs up to 0.75 per cent. Aconine has a cardiac depressant action. If 1 mg. of aconitine is mixed with 2 drops of  $H_2SO_4$ , containing 5 mg. of ammonium vanadate in a cc., an orange color is produced.

**Uses.**—Aconite, when applied locally in the form of the tincture, is a peripheral stimulant to the sensory nerves, producing tingling and later, depression, evidenced by numbness. Taken internally, it stimulates the vagus center, slowing the heart rate. It has been used as a cardiac depressant in high arterial tension of cardiac origin; locally in the form of diluted tincture or liniment as an analgesic in facial neuralgia, rheumatism, toothache, etc.

**Average Dose.**—60 mg. (1 grain); of Aconitine (U.S.P. X), 0.00015 Gm. ( $\frac{1}{400}$  grain).

**Preparations.**—Aconite Tincture, N.F., 0.6 cc. (10 m); Aconite Fluidextract, N.F., 0.06 cc. (1 m); Aconite and Chloroform Liniment, N.F. (from Fld. ext.).

**Substitutes and Adulterants.**—1. *Japanese Aconite Root*. Two roots bearing this commercial designation occur on the market. The first of these, yielded by *Aconitum Fischeri* Reich., is of conical shape, smaller, less wrinkled, of lighter weight and more mealy than the official article. It is claimed to contain an alkaloid called *jesaconitine*. The second is yielded by *A. uncinatum* L. var. *japonicum* Regel. This root is also conical, smaller, starchy, and less wrinkled than N.F. aconite; the daughter tuberous root is dark-gray and nearly smooth while the parent root is brownish and marked with slightly raised longitudinal ridges. It contains *japaconitine*. Both of these Japanese Aconites have an uneven, wavy ellipsoidal or circular cambium with numerous collateral fibrovascular bundles arranged along its course.

2. *Root of Aconitum chasmanthum* Stapf. This Indian aconite root is paired and tuberous, the daughter tuber conic to conic-cylindric from a broad base, 2.5 to 3.7 cm., rarely up to 5 cm. in length and up to 18 mm. in thickness with rootlet stubs mostly clustered at the basal end, dark brown externally with a cartilaginous fracture. Its cambium is continuous and sinuous in cross section. It contains *indaconitine*.

3. *Indian or Nepal Aconite* is the root of *A. laciniatum* Stapf. It is conical to curved-conical, larger than the official root, being up to 15 cm. long and 4 cm.





FIG. 149.—Tuberos roots of *Aconitum Störckianum*, which have been admixed with and substituted for the official *Aconitum*.  $\times \frac{1}{2}$ . These roots contain aconitine and aconine and the plant is believed to be a hybrid between *A. Napellus* L. and *A. variegatum* L.

thick near the crown, dark brown and deeply wrinkled externally, generally horny internally with a wavy, stellate, brown pith. It contains numerous altered gelatinized starch grains as well as some unaltered starch grains, the latter simple or 2- to 3-compound, the individual grains up to  $30.88\mu$  in diameter. It contains *pseudaconitine*, a respiratory depressant which is much more toxic than aconitine.

4. Root of *Aconitum deinorrhizum* Stapf., another Indian species native to the Alpine Himalayas of Bashahr. It occurs as paired biennial tuberous roots,



FIG. 150.—Indian or Nepal Aconite Root from *Aconitum laciniatum*.

the daughter tuber being elongated-conical, up to 6.5 cm. long and up to about 18 mm. thick at the crown. Its cambium is discontinuous, being broken into circular, horse-shoe shaped or flattened strands arranged in a ring. It contains *pseudaconitine* ( $C_{36}H_{49}NO_{12}$ ).

5. Roots of *Aconitum Balfourii* Stapf. from India which somewhat resemble those of the preceding species in structure. It contains *pseudaconitine*.

6. Root of *Aconitum ferox* Wallich ex Seringe. This is obtained from another Indian Aconite, native to the Alpine Himalayas of Nepal. The root is paired, tuberous and biennial. The daughter tuber is ovoid oblong to ellipsoidal, up to 4 cm. long and 1.5 cm. in thickness; fracture scarcely farinaceous, the fractured surface being yellowish and showing a 7- to 9-angled cambium. It contains *pseudaconitine*.

7. Root of *Aconitum Störckianum* Reichb., believed by Tschirch and Hegi to be a hybrid of *Aconitum Napellus*  $\times$  *A. variegatum* L., with a conical root

often occurring in clusters of 3 or 4, consisting of a parent and 2 or 3 daughter tuberous roots. Its cambium is 4- to 10-angled, the angles stumpy, there frequently being 4 large angles with smaller ones between these. The bundles are strung out along the entire cambium line. Its starch grains are simple or 2- to 5-compound, the individual grains being spheroidal to plano-convex and angular-convex and up to  $23.3\mu$  in diameter, a number having a central cleft hilum. It contains *aconitine*.

8. Roots of unidentified species of *Aconitum* or hybrids of *A. Napellus*.

**Allied Species.**—*A. Lycoctonum* L., a yellow flowered form indigenous to Europe and N. Asia, possesses a several headed rhizome which contains *lycaconitine* and *myoconitine*. *A. heterophyllum* Wallich of India possesses small fusiform or ovoid grayish roots which are bitter but not acrid or benumbing and contains the alkaloid, *atisine*. *A. paniculatum* Lam. contains *paniculatine* while *A. spicatum* Lam. contains *bikhaconitine*.

#### HYDRASTIS N.F. (HYDRASTIS)

**Synonyms.**—*Goldenseal*, Yellow Puccoon, Yellow Root, Orange Root, *Hydrastidis rhizoma* P.I., Ground Raspberry, Indian Paint; *Fr.* Sceau d'Or; *Ger.* Canadische Gelbwurzel.

**Botanical Origin.**—*Hydrastis canadensis* Linné.

**Part Used.**—The dried rhizome and roots.

**Standard of Assay.**—Not less than 2.5 per cent. of the anhydrous ether-soluble alkaloids of Hydrastis.

**Limit of Impurities.**—Not more than 4 per cent. of foreign organic matter. It yields not more than 3 per cent. of acid-insoluble ash.

**Habitat.**—In rich well-drained woodlands of North America, east of the Mississippi.

**Plant.**—A perennial herb, known to the Cherokee Indians who used its underground portion both for dyeing and as an internal remedy. Its valuable properties were presented by them to the early American settlers. The underground portion of the plant consists of a horizontal, branching rhizome bearing numerous long slender roots. The aerial portion consists of a single radical leaf and a short stem 1 to 1.8 dm. in length which bears near its summit 2 petiolate, palmately 5-7-lobed, serrate leaves and ends with a solitary greenish-white flower that opens in April or May. The fruit consists of a compound crimson berry which has an appearance somewhat like that of the raspberry.

**Production and Commerce.**—Although plentiful in our virgin forests, Golden Seal, as a wild plant, has become very scarce during the past quarter of a century. Some of the drug is obtained from plants growing wild in Indiana, Ohio, Missouri, Georgia, Tennessee, Minnesota, West Ontario, and West Virginia. Considerable of the drug is now obtained from plants cultivated in the Pacific northwest and in North Carolina. Large goldenseal gardens are at Anacortes, Bow, and Burlington, Washington, at Estacate, Oregon, and many growers are engaged in Swain County, N. C.

The plants are usually propagated by seedlings or by cuttings of the rhizome. Seedlings may be procured by sowing the seeds in mid-autumn in seed beds containing abundant leaf mold. After planting, the seeds should be covered with an inch of fine leaf mold and protected during the cold winter season by covering the beds with burlap. After the seedlings have developed to the height of about

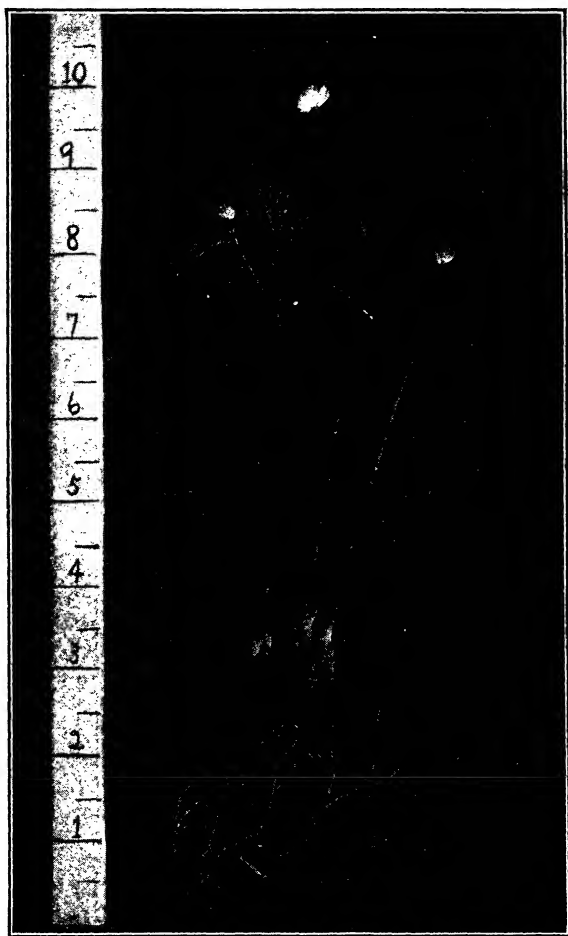


FIG. 151.—*Hydrastis canadensis*. Flowering plants.

2 inches, they can be set out in cold frames or transplanted to pots to harden their root-system. They are later planted out in the open in well-fertilized soil containing abundant leaf mold, being set 6 or 8 inches apart, and protected in summer against excessive light and heat by lath-shade or vines. The ideal location in which to grow *Hydrastis* either from seedlings or cuttings is on the sloping side of a woodland hill where shade is abundant and drainage excellent. The rhizomes and roots should be collected in autumn after the aerial portion of the plant has withered. Plants grown from rhizome cuttings are generally

ready for collection the third or fourth year, while those grown from seed should not be collected until the fifth year. The rhizomes and roots are washed clean and then dried on a clean dry floor or in partial shade, protected from rain, outside. They are kept in loose masses until marketed, in order to prevent mold attack.

**Description.**—*Rhizome* horizontal or oblique, sub-cylindrical, from 1–6 cm. in length and from 2–10 mm. in diameter, occasionally with stem bases; exter-



FIG. 152.—*Hydrastis* under cultivation. (Reproduced from Farmer's Bulletin 613, "Goldenseal Under Cultivation.")

nally brown to dusky yellowish-orange, marked by numerous stem scars and more or less annulate from scars of bud-scales, otherwise deeply longitudinally wrinkled; on the under and lateral portions arise many long slender roots which are easily detached; fracture short, waxy; internally of a weak yellow-orange color in center, greenish-yellow near margin and exhibiting an interrupted circle of small, radially elongated fibrovascular bundles. *Roots* numerous, filiform, up to 35 cm. in length and 1 mm. in diameter; curved, twisted and matted together or broken; fracture short and brittle, internally weak yellowish-orange to moderate greenish-yellow. Odor distinct; taste bitter.

**Histology.**—Transverse sections of the *rhizome* exhibit the following internal peculiarities:

1. *Epidermis* or cork, depending on age, with thin, yellowish-brown, suberized cells.
2. *Cortex* of about 25 layers of thin-walled, cortical parenchyma cells frequently showing traces of root outgrowths.

3. A circle of 12 to 20 radiately elongated, *open collateral, fibrovascular bundles* separated by yellowish orange to greenish yellow medullary rays up to 30 cells in width. In fully developed bundles, there is to be observed a more or less collapsed phloem and cambium and a radially elongated xylem with a prominent group of wood fibers near the pith. The remainder of the xylem is composed of tracheæ, tracheids and wood parenchyma, some of the last containing yellowish contents.

4. *Pith*, a broad zone of parenchyma cells.



FIG. 153.—*Hydrastis* rhizomes, more or less deprived of many of their rootlets,  $\times 1\frac{1}{2}$ . (Photograph by Stoneback.)

Transverse sections of *Hydrastis* roots show the following:

1. *Epidermis* of a single layer of yellowish-brown, elongated epidermal cells with suberized outer walls, some giving rise to root-hairs.
2. *Cortex* of thick-walled, starch-containing parenchyma.
3. *Endodermis* of slightly lignified endodermal cells.
4. *Pericambium* of more or less collapsed thin-walled cells.
5. *Radial fibrovascular bundle* of 2 to 6 xylem patches alternating with as many phloem arms.
6. *Pith*, consisting of a small central area of parenchyma.

**Identification Tests.**—Sections prepared from the rhizome which has been macerated in water, when mounted in concentrated sulfuric acid and examined under the microscope, exhibit the formation of numerous needle- or rod-shaped crystals, some attaining a length of  $200\mu$ . These crystals represent sulfates of hydrastine and berberine.

Under filtered ultra-violet light, broken or abraded surfaces of *Hydrastis* exhibit a brilliant yellow fluorescence.

**Powdered Drug.**—Dark yellow to moderate greenish yellow with a distinctive odor and bitter taste; numerous spherical, simple starch grains, averagely  $2\mu$  to  $15\mu$  in diameter, the larger exhibiting a central hilum; a few 2- to 6-compound starch grains; fragments of starch-bearing parenchyma; fragments of

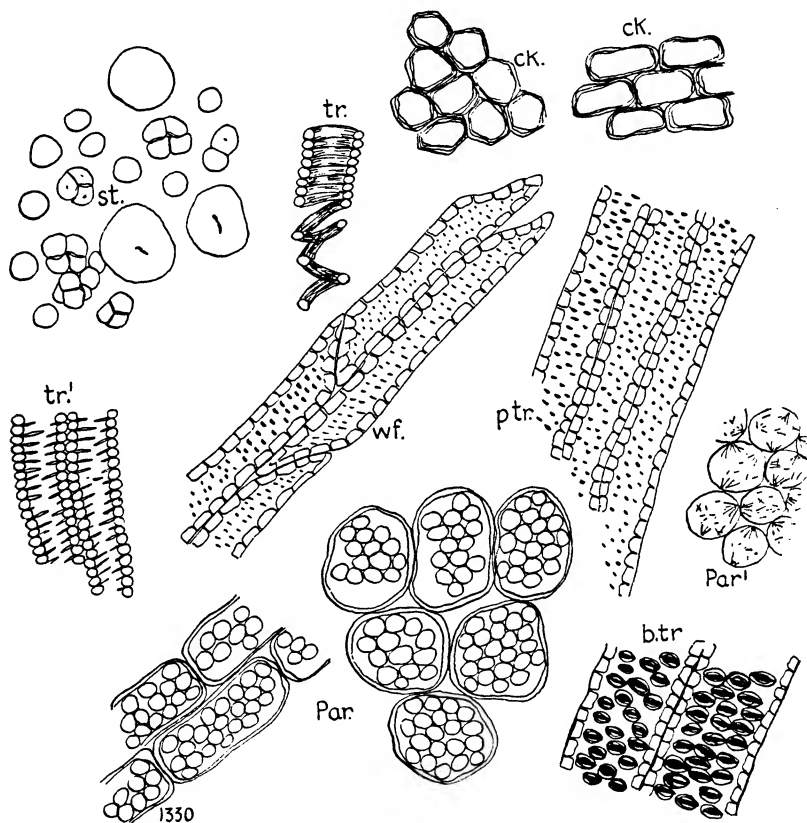


FIG. 154.—Powdered *Hydrastis*. *st.*, starch grains; *tr.*, spiral trachea; *tr'*, pitted trachea; *wf.*, wood fibers; *ptr.*, trachea with simple pores; *par.*, parenchyma bearing starch; *b.tr.*, trachea with bordered pores; *par'*, parenchyma containing short acicular crystals of a sulfate of an alkaloid, formed by treating powdered hydrastis with sulfuric acid; *ck.*, cork.

fibrovascular tissue, the trachea with simple and bordered pores, some with spiral thickenings, the wood fibers from 200 to  $300\mu$  in length, thin-walled and with simple pores; a few fragments of cork tissue, the cells of which have reddish brown walls. *Calcium oxalate crystals are absent.*

**Constituents.**—The alkaloids *hydrastine* (colorless), *berberine* (yellow) and *canadine*; starch, etc. Hydrastine ( $C_{21}H_{21}O_6N$ ) forms colorless rhombic prisms from alcohol. Its hydrochloride is a white to creamy white microcrystalline powder, very soluble in water and alcohol and is official in the N.F. Berberine crystallizes from water in yellow to reddish-yellow needles and from

chloroform in triclinic tablets. It is very soluble in hot water and alcohol and sparingly soluble in cold water.

**Uses.**—Hydrastis is an "alterative" to mucous membranes and a bitter tonic. It is sometimes employed in gastro-intestinal and nasal catarrh, in inflammation of the mucous membrane of the vagina, uterus and urethra, in menorrhagia, hemorrhoids, etc. **Hydrastine hydrochloride N.F.** is a local vaso-constrictor. It is used locally in aqueous solution in catarrhs, nose bleed, etc. and internally as a uterine stimulant.

**Average Dose.**—2 Gm. (30 grains); of Hydrastine hydrochloride, 10 mg. ( $\frac{1}{6}$  grain).

**Preparations.**—In N.F.: Hydrastis Extract, 0.5 Gm. ( $7\frac{1}{2}$  gr.); Hydrastis Fluidextract, 2 cc. (30 m.); Hydrastis Tincture, 8 cc. (2 fl. dr.); Alkaline Rhubarb Elixir (from Fldext.), 4 cc. (1 fl. dr.).

**Adulterants.**—Rhizomes and roots of *Jeffersonia diphylla*, *Cypripedium* species, and *Aristolóchia Serpentaria*.

#### CIMICIFUGA N.F. (CIMICIFUGA)

**Synonyms.**—*Black Snakeroot*, *Black Cohosh*, *Macrotys*, *Bugbane*; *Ger. Schwarze Schlangenwurzel*; *Fr. Racine d'Actée à Grappes*.

**Botanical Origin.**—*Cimicifuga racemosa* (Linné) Nuttall.

**Part Used.**—The dried rhizome and roots.

**Purity Rubric.**—Not more than 5 per cent. of attached stem bases and not more than 2 per cent. of other foreign organic matter. It yields not more than 4 per cent. of acid-insoluble ash.

**Habitat.**—In rich woods of eastern North America.

**Plant.**—A perennial herb whose subterranean portion consists of a thick, knotted rhizome system. Its aerial stem grows to the height of 1 to 2.5 m. Its leaves are decompose, the leaflets cut serrate along the margin and subcordate to subcuneate at the base. The inflorescence is a long wand-like raceme of white flowers.

**Production and Commerce.**—The drug is chiefly collected from plants growing wild in the Blue Ridge. Scattering collections are made in Indiana, Michigan, Illinois and Northern Pennsylvania. It is shipped either in bales or bags.

**Description.**—The drug occurs as a mixture of entire and broken rhizomes and roots. Rhizome horizontal, somewhat branched, from 2 to 15 cm. in length and from 1 to 2.5 cm. in thickness; externally dusky brown, sometimes slightly annulate from circular scars of bud scales; the upper surface with several buds and numerous large stem bases terminated, frequently, by deep, cup-shaped, radiating scars, each of which shows a radiate structure; or less frequently by fibrous strands, lower and lateral surfaces with numerous root scars and a few short roots; fracture horny; internally whitish and mealy or dark brown and waxy, bark thin, wood radiate and of about the same thickness as the pith; odor slight; taste bitter and acid.

Roots cylindrical or obtusely 4-angled, up to 3 mm. thick; externally dusky



brown to dark yellowish brown, longitudinally wrinkled; fracture short to short-fibrous; internally cortex thin and dark colored, wood yellowish and showing 3 to 6 rays.

**Histology.**—Transverse sections of the rhizome exhibit a yellowish brown suberized epidermis, several layers of starch- and resin-containing cortical parenchyma, two circles of open collateral fibrovascular bundles, the outer being

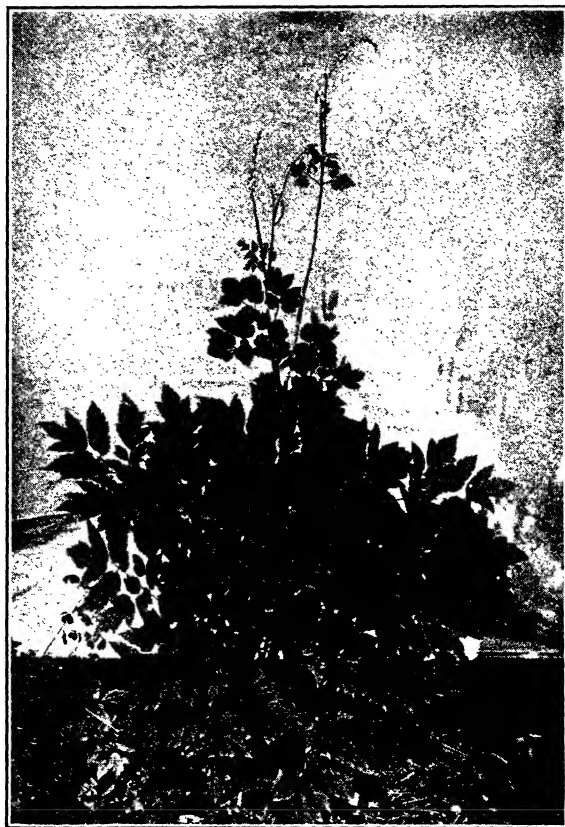


FIG. 155.—*Cimicifuga racemosa*. Flowering plant.

smaller than the inner bundles. The xylem contains tracheæ with bordered pores and numerous strongly lignified wood fibers; medullary-rays separating the bundles and containing starch, and a central pith whose cells resemble those of the cortex. See Fig. 157.

Transverse sections of the root exhibit a thin epidermis, a cortex, separated into two zones by a distinct endodermis, and 4 to 6, occasionally 3, open collateral fibrovascular bundles separated by broad wedge-shaped medullary-rays. See Fig. 158.

**Constituents.**—From 15 to 20 per cent of *resin*, a crystallizable bitter principle called *racemosin*, an acid *saponin*, a glycoside tannin containing a phloba-

phene, another *water-soluble glycoside*, another *glycoside* stated to possess a cardiotoxic action when administered intravenously to dogs, isoferulic, palmitic and oleic acids, starch, etc. *Macrotoxin* or *cimicifugin* is a mixture of resinous



FIG. 156.—*Cimicifuga*. At right is portion of aerial stem (above) and root (below).  $\times \frac{1}{2}$ .

substances prepared by pouring a concentrated alcoholic tincture of the drug into water and separating and drying the precipitate.

**Uses.**—*Cimicifuga* is employed as an anti-rheumatic and as a remedy for chorea, dysmenorrhœa, neuralgia, and tinnitus aurium.

**Average Dose.**—1 Gm. (15 grains).

**Preparations.**—*Cimicifuga* Fluidextract, 1 cc. (15 m). Compound Sodium Salicylate and Gelsemium Elixir, 4 cc. (1 fl. dr.).

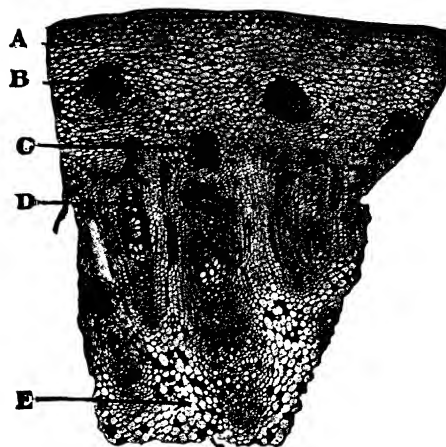


FIG. 157.—Transverse section of *Cimicifuga* rhizome (representative portion),  $\times 18$  diameters. A, cortex. B, fibrovascular bundle. C, phloem. D, xylem. E, pith. Note anomalous structure with concentrically arranged portions of two circles of bundles. (*Photomicrograph, after Sayre.*)

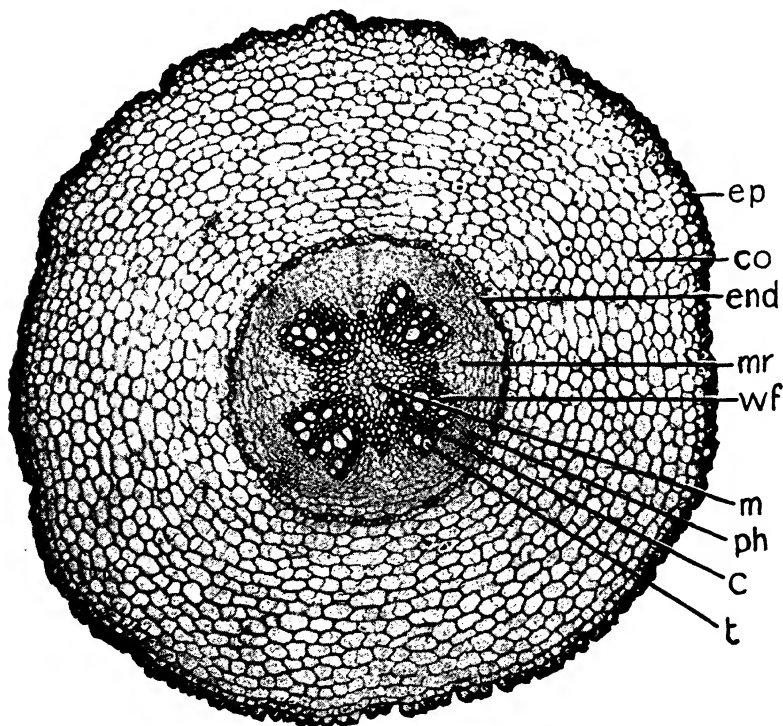


FIG. 158.—*Cimicifuga* rootlet. Photomicrograph of a cross section,  $\times 52$ . ep, epidermis; co, cortex; end, endodermis; mr, medullary ray; ph, phloem, c, cambium, t, trachea and wf, wood fibers of an open collateral fibrovascular bundle; m, pith. Note the bundles arranged in a maltese cross.

**Adulterants.**—Excessive aerial stems of same plant and dirty roots are the chief causes of inferiority of this drug. Rhizomes and roots of *Actæa alba* and *Actæa rubra* have been fairly common adulterants.

#### STAPHISAGRIA (STAPHISAGRIA)

**Synonyms.**—Stavesacre, Semen Pedicularis; *Ger.* Stephanskörner, Läusekörner; *Fr.* Staphisaigre.

**Botanical Origin.**—*Delphinium Staphisagria* Linné.

**Part Used.**—The dried ripe seed.

**Limit of Impurities.**—2 per cent. of foreign vegetable matter.

**Habitat.**—Asia Minor and Southern Europe.

**Plant.**—An erect annual herb about 4 ft. in height with palmate, 5-9-lobed, pubescent leaves. Its flowers are purplish with spurred calyx and borne in racemes. Its fruit consists of 3 downy follicles, each containing about 12 angled seeds.

**Production and Commerce.**—Stavesacre is cultivated in Italy and France, the seeds being collected from the follicles when ripe. The commercial supplies of this drug are imported from Leghorn, Italy.

**Description.**—A somewhat tetrahedral, albuminous seed, one surface being convex, the others plane, from 4 to 10 mm. in length and 3 to 8 mm. in breadth; externally dark brown, or grayish, coarsely reticulate; easily cut, the cut surface showing a bluish-gray oily endosperm, enclosing a small embryo at the pointed end; odor slight; taste very bitter and acrid.

**Constituents.**—The alkaloids *delphinine*, *delphisine*, *delphinoidine*, and *staphisagroine*; resin, fixed oil, etc. Delphinine resembles aconitine in its action.

**Uses.**—Parasiticide in pediculosis, usually in the form of a tincture; cardiac depressant.

**Dose.**—60 mg. (1 grain).

#### LARKSPUR N.F. (DELPHINIUM)

**Synonyms.**—*Larkspur Seed*, Field Larkspur, Lark's Claw, Knight's Spur; *Ger.* Feldritterspornsamensamen.

**Botanical Origin.**—*Delphinium Ajacis* Linné.

**Part Used.**—The dried ripe seed.

**Habitat.**—Europe. Naturalized in the United States.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Plant.**—An erect annual, about 1½ ft. high with sessile stem leaves deeply cut into linear segments. The flowers are blue, violet, pink or white, each with 2 united petals and a spurred calyx and arranged in a raceme. The fruit consists of a single pubescent follicle containing many small, ridged seeds.

**Production and Commerce.**—The commercial supplies of this drug are imported from Europe and Argentina.

**Description.**—Seed albuminous, irregularly tetrahedral, acute at one end, obtuse or rounded at the other, about 2 mm. in length and almost as wide, seed

coat crustaceous, its outer surface brownish black to dark yellowish brown or grayish with from 8 to 12 ridges transversely encircling the seed and forming wavy continuous vertical walls or ruffles, occasionally intersecting, and with narrow channels between; endosperm light gray, fleshy and oily; embryo small, embedded in endosperm; odor indistinct; taste bitter, later biting and acrid.

**Powdered Drug.**—Brown to olive-gray; numerous fragments of endosperm composed of thick-walled parenchyma containing fixed oil and aleurone grains; aleurone grains up to  $12\mu$  in length; fragments of elongated epidermal cells, up to  $300\mu$  in length and  $45\mu$  in diameter; groups of elongated cells from the inner layer of the seed coat up to  $10\mu$  in width with characteristic beaded walls.

**Constituents.**—The crystalline alkaloids *ajacine* and *ajaconine*, resin, fixed oil, etc.

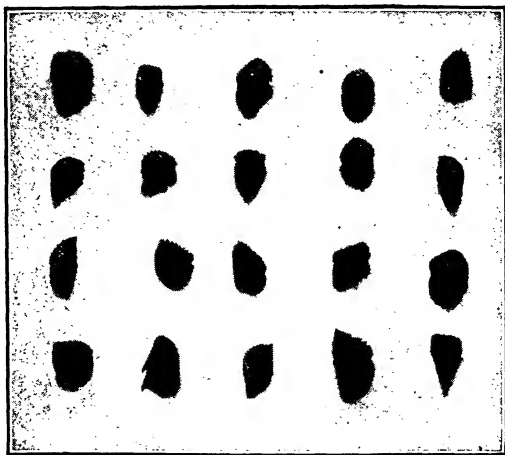


FIG. 159.—Delphinium,  $\times 4$ .

**Use.**—Larkspur is employed externally in the form of its tincture and acetic tincture as a parasiticide in pediculosis. Internally its action somewhat resembles aconite.

**Dose** (unof.).—0.06 Gm. (1 grain).

**N.F. Preparations.**—Larkspur Tincture, Acetic Larkspur Tincture.

#### COPTIS (COPTIS)

**Synonym.**—Goldthread, *Ger.* Gelbe Niesswurz; *Fr.* Coptide.

**Botanical Origin.**—*Coptis groenlandica* (Oeder) Fernald.

**Part Used.**—The dried plant.

**Purity Rubric.**—Not more than 3 per cent. of foreign organic matter (N.F. V).

**Habitat.**—Northern North America, south to Maryland, mountains of North Carolina and Tennessee and northeast Iowa.

**Plant.**—A low perennial herb found in woods and swamps. Its underground portion consists of a slender (filiform) rhizome of orange or deep golden-yellow

color bearing several hair-like rootlets from the lower surface of each of its nodes. Its aerial portion consists of several radical leaves that are evergreen, long petioled and trifoliate, and a slender scape 7 to 12.5 cm. high which bears a small white flower from May to July. The fruit consists of 7 follicles containing small black seeds.

**Production and Commerce.**—Goldthread is collected when in flower, dried and marketed both in the form of entire plants and as rhizomes. Most of the

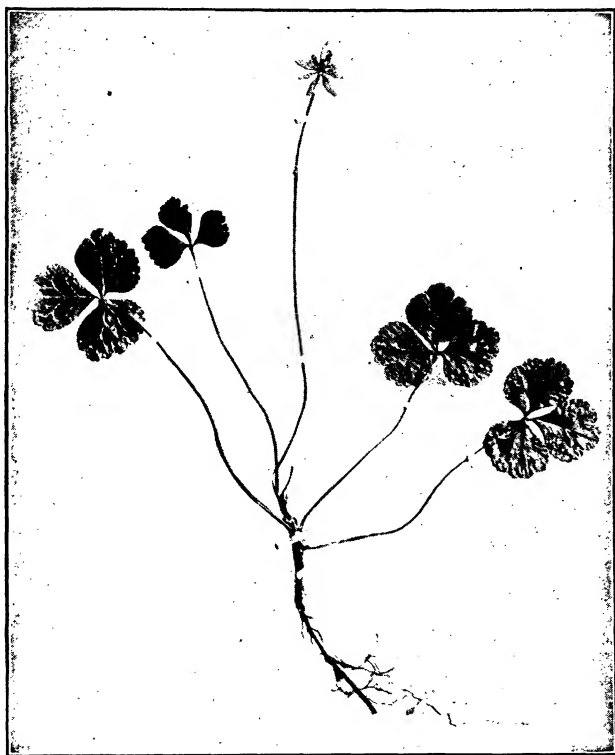


FIG. 160.—*Coptis groenlandica*. Plant.

commercial supplies are gathered in the "Blue Ridge" district, smaller amounts in New England.

**Description.**—It occurs in loose matted masses consisting of long, filiform, orange-colored, cylindrical, branched rhizomes, slender hair-like roots and leaves. The leaves are coriaceous, trifoliate, evergreen, with long slender petioles. The segments of the lamina are broadly obovate-cuneate, crenately lobed and toothed with sharp-pointed teeth, prominently veined, dark green and shining, often becoming brown upon drying. The flowers when present, are small, solitary, terminating slender scapes, whitish or light brown, each with 5-7 small, petaloid, deciduous sepals, 5-7 small, club-shaped, pale yellow petals, numerous stamens and 7 carpels. The fracture of the rhizome is weak and brittle. The odor is indistinct. The taste is bitter.

**Constituents.**—A yellow alkaloid (*berberine*) and another alkaloid (*coptine*) which gives a purple coloration when heated with sulfuric acid, starch, etc.

**Uses.**—Coptis is employed as a bitter tonic and for ulcerated mouth.

**Average Dose.**—2 Gm. (30 grains).

ADONIS (ADONIS) H.P.

**Synonyms.**—Pheasanteye, Pheasant's Eye, False Hellebore, Spring Adonis; *Ger.* Sommerteufelsauge; *Fr.* Adonis.

**Botanical Origin.**—*Adonis vernalis* Linné.

**Parts Used.**—The entire fresh plant (H.P.). The dried overground portion, (N.F. VII).

**Purity Rubric.**—Not more than 5 per cent. of foreign organic matter, it yields not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—Northern Europe and Asia.

**Plant.**—A perennial herb.

**Production and Commerce.**—The drug is obtained during the late spring from plants which grow wild or are cultivated in central and southern Europe. It is dried and then tied in bundles for the market. The commercial supplies are imported from Hamburg, Germany.

**Description.**—Adonis occurs in light olive to dusky greenish yellow bundles of the entire aerial portions of plants or pieces of the same. Stems up to 50 cm. in length, simple or branched, longitudinally grooved, soft and weak, shining, the branches mostly from near the base and resembling the main stem, naked below, except for some scale-like leaf vestiges, densely foliaceous above; leaves 2 to 4 cm. long and 1.5 to 3 cm. broad, pinnately-divided into several segments, the larger of which are again divided, the ultimate segments being linear and acute; flowers terminal, yellow usually, becoming cream-colored on drying, from 3 to 6 cm. in breadth; sepals 5, weak brown to weak olive, hairy, more than half the length of the petals, ovate, obtuse, finely veined; petals from 5 to 20, light yellow to moderate greenish yellow, concave, oblong, obtuse, finely veined and slightly longer than the sepals; stamens indefinite; carpels, apocarpous, numerous, forming in the fruit an ovoid, obtuse, dense head of ovoid akenes each tipped with a small persistent style; odor faint; taste bitter and slightly acrid.

**Powdered Drug.**—Dusky greenish yellow to light olive; starch grains and calcium oxalate crystals few or absent; numerous fragments of the parenchyma of the medulla whose cells are up to  $50\mu$  in width and  $250\mu$  in length and exhibit porous walls; fragments containing narrowly elongated sclerenchymatous fibers with lignified walls from 5 to  $7\mu$  thick and with a few rounded or oblique simple pores; tracheæ either spiral or with bordered pores and up to  $17\mu$  in width; epidermal cells of the stems and leaf stalks elongated in surface view with elliptical stomata; portions of epidermis of the leaf blade exhibiting striated epidermal cells with wavy vertical walls and elliptical stomata up to  $64\mu$  in length; red to orange fragments from the scales at the base of the stem, composed of elongated cells with rounded ends and orange to yellow walls.

**Constituents.**—The amorphous cardiac glycosides, *adonidoside* and *adonivernoside*; *adonidinic acid*; *adonitol*, a penta-hydroxy-pentane; choline, resin, etc. *Adonidin* (Cervelo, 1882) is a mixture of the glycosides with adonidinic acid.

**Use.**—Cardiac stimulant and tonic of the *Digitalis* group. It is used in threatened cardiac failure in the form of the fluidextract or infusion. *Adonidin*



FIG. 161.—*Adonis vernalis*. Note the pinnately-dissected leaves and terminal flowers.

is also employed as a cardiac tonic. The entire fresh plant is recognized by the homeopathic pharmacopœia.

**Average Dose.**—0.125 Gm. (2 grains); Dosage of Adonidin,  $\frac{1}{12}$  to  $\frac{1}{4}$  grain.

**Adulterant and Substitute.**—The overground portion of *Adonis æstivalis* Linné or Summer Adonis whose stems are frequently branched at the top and whose flowers are crimson with flat petals about  $1\frac{1}{2}$  times as long as the calyx. It contains a glycoside resembling adonidin but the drug is weaker in action.



## PULSATILLA (PULSATILLA) H.P.

**Synonyms.**—Pasqueflower, Wind Flower, Prairie Anemone; *Ger.* Kuchenschelle; *Fr.* Coquelourde.

**Botanical Origin.**—(1) *Anemone Pulsatilla* Linné, (2) *Anemone pratensis* Linné, or (3) *Anemone patens* Linné.



FIG. 162.—Pulsatilla.

**Part Used.**—The fresh flowering plant (H.P.). The dried herb (N.F. VII).

**Purity Rubric.**—Not more than 5 per cent. of foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—1. Europe and Asia. 2. Europe and Asia. 3. Canada and United States, west of the Mississippi.

**Plants.**—Perennial herbs with twice or thrice pinnately-divided or cleft basal leaves and erect stems whose sessile, cauline leaves form an involucre near the flower. The single flower which terminates the stem varies from blue to bluish-purple or reddish-purple. The fruit is an achene with a long feathery style.

**Production and Commerce.**—Pulsatilla is produced chiefly in Czechoslovakia and reaches this country in bags or bales shipped from Hamburg, Germany. American Pulsatilla was grown in fair sized lots in the Western United States during the first World War.

**Description.**—Leaves and flowering scapes matted; basal leaves silky villous, the base of the petiole more hairy than above; petioles up to 30 cm. in length, hollow, often dusky red to weak yellow in color, and frequently attached to the short rootstock; the blades twice or thrice deeply 3- or 4-parted or pinnately cleft, the lobes linear and acute. Flowering scapes up to 30 cm. in length, solid in the lower portion and hollow in the upper part, with sessile, involucrel, dissected leaves near the flower, occasionally with remains of the weak red to yellow hairy sepals and the dense-woolly, plumose-tailed akenes. Nearly odorless; taste very acrid, diminishing on keeping.

**Constituents.**—*Volatile oil* containing anemonol (pulsatilla camphor); a crystalline *vesicant principle* which readily decomposes into anemonin and isonanemonic acid in the presence of water; bitter principle, tannin, etc.

**Uses.**—Pulsatilla is used in the treatment of amenorrhœa and dysmenorrhœa. Its action is that of an irritant.

**Average Dose.**—0.3 Gm. (5 grains).

**Preparations.**—Tinctura Pulsatillæ, N.F. VII, 2 cc. (30 minims); Tincture of fresh plant, H.P.

#### BERBERIDACEÆ (BARBERRY FAMILY)

Herbs and woody plants with watery juices and alternate, cauline or radical, simple or compound leaves often bearing spines or barbs, which give them a barbed appearance. Fruit, a berry or capsule.

#### BERBERIS (BERBERIS)

**Synonyms.**—Oregongrape Root, Barberry, Trailing Mahonia, Rocky Mountain Grape; *Ger.* Gemeiner Sauerdorn, Berberitzenwurz; *Fr.* Vinettier.

**Botanical Origin.**—Various species of the Section *Mahonia* (Nuttall) De Candolle of the genus *Berberis* Linné.

**Parts Used.**—The dried rhizome and roots. The fresh bark of the root of *Berberis Aquifolium* (H.P.).

**Purity Rubric.**—Not more than 5 per cent. of attached overground stems and not more than 2 per cent. of other foreign organic matter. It yields not more than 2 per cent. of acid-insoluble ash. Pieces of the rhizome or root over 45 mm. in diameter or with bark removed must be rejected. N.F. VII.

**Habitat.**—Rocky Mountain range of North America and westward.

**Plants.**—Shrubs with smooth stems, yellow wood and flowers, and compound leaves bearing leaflets with dentate margins and spines. Fruit a berry.

**Production and Commerce.**—Berberis is obtained chiefly from *B. Aquifolium* and *B. nervosa* growing in Washington, Oregon and California. It is shipped in bags.

**Description.**—In simple or branched cylindrical segments of the rhizome and roots of variable length and up to 45 mm. in diameter; usually splitting somewhat on drying; externally light yellowish brown to pale olive, longitudinally wrinkled, short-scaly; and showing small irregular fissures in the cork; fracture

hard and tough; internally showing a very thin brownish green, soft bark about 1 mm. in thickness, easily separable into layers, a broad light yellow to weak greenish yellow wood, becoming deeper yellow upon wetting, and exhibiting numerous radiating narrow, medullary-rays and showing annular rings, and a small, yellow, sometimes eccentric pith (rhizome) or no pith (root); odor slight; taste bitter; on chewing it colors the saliva yellow.

**Histology.**—Transverse sections made through the rhizome exhibit the following internal structures:

1. *Cork*, a narrow irregular zone of brownish, somewhat collapsed cells.
2. *Cork cambium*, of somewhat collapsed meristematic cells.
3. *Cortex* of only a few layers of tangentially-elongated parenchyma cells with yellowish amorphous contents.
4. Numerous radially elongated, *open collateral fibrovascular bundles* arranged in a circle and separated by starch-containing medullary-rays that are for the most part narrow. Each bundle consists of an outer phloem composed of alternating horizontal groups of bast fibers and soft bast, a cambium of more or less collapsed cells, and a very broad, porous xylem composed of numerous wood fibers intermingled with pitted and reticulate tracheæ.
5. *Pith*, a narrow central zone of parenchyma tissue, the cells of which contain simple or 2- to 3-compound starch grains and active principles.

Similar sections made through the root show curved medullary-rays and no pith. Otherwise they resemble the rhizome.

**Powdered Drug.**—Moderate yellowish brown to weak greenish yellow, showing for the most part fragments of yellowish wood fibers with large transverse pores and medullary rays associated with a few tracheæ having chiefly bordered pores or occasionally reticulate markings; starch grains single or 2- to 3-compound, the individual grains somewhat spheroidal and mostly from 3 to 20 $\mu$  in diameter; fragments of parenchyma, some containing starch, others a yellowish amorphous substance.

**Constituents.**—The alkaloids *berberine*, *oxyacanthine*, *berbamine*; resin and starch.

**Use.**—Bitter tonic.

**Average Dose.**—2 Gm. (30 grains).

**Preparation.**—Fluidextractum Berberidis N.F. VII, 2 cc.

**Adulterants.**—(1) Aerial stem of lighter yellow color and having cork that detaches in long strips. (2) Rhizomes and roots of a South American species of *Berberis*.

#### CAULOPHYLLUM N.F. (CAULOPHYLLUM)

**Synonyms.**—*Blue Cohosh*, Pappoose Root, Squaw Root.

**Botanical Origin.**—*Caulophyllum thalictroides* (L.) Michaux.

**Parts Used.**—Dried rhizome and roots.

**Purity Rubric.**—Not more than 3 per cent. of foreign organic matter and not more than 4 per cent. of acid-insoluble ash.

**Habitat.**—Eastern North America in deep rich woodlands.

**Plant.**—A perennial herb having a thick, crooked, horizontal rhizome that sends up in the spring a smooth stem 3 to 7 dm. high, which is terminated by a panicle of yellowish-green flowers. A short distance below the flower cluster the stem bears a large sessile, tritermately compound leaf having 2- to 3-lobed leaflets.

**Description.**—Rhizome branched, crooked, of horizontal growth, from 7 to 25 cm. long and from 5 to 15 mm. thick, showing on its upper surface broad cup-shaped stem-scars and short bases of stems, and on all surfaces tough and



FIG. 163.—*Caulophyllum* (Blue Cohosh) nat. size.

wiry, matted together rootlets, dusky brown to light yellowish brown; fracture tough and woody; internally light brown to light yellowish brown with a waxy luster; bark thin; wood with numerous small wood wedges separated by narrow medullary-rays and inclosing a broad pith. Roots in a tangled or matted mass, long, tortuous, thin, dusky brown to light yellowish brown externally, with a tough fracture, each with a 4-rayed xylem. Odorless but sternutatory when powdered. Taste very bitter and acrid.

**Powdered Drug.**—Pale brown to weak yellowish-orange; sternutatory. It shows fragments of yellowish-brown epidermis with polygonal shaped cells; fragments of yellowish tracheæ and tracheids with irregularly circular bordered pores; fragments of wood fibers with thick, lignified walls, a few oblique pores and usually curved ends; fragments of starchy parenchyma, and numerous more or less spheroidal starch grains up to  $18\mu$  in diameter mostly simple, spheroidal or ovate with an indistinct hilum.

**Constituents.**—*Caulophylline* (a crystalline alkaloid), *caulosaponin* (crystalline glucoside), *caulophyllosaponin* (a saponin-glucoside), a phytosterol glucoside called citrullol, volatile oil, *resin*, enzyme, starch, etc.

**Uses.**—Blue cohosh is used empirically as an antispasmodic, emmenagogue and oxytocic.

**Average Dose.**—0.5 Gm. ( $7\frac{1}{2}$  grains).

**Preparation** (unof.).—Fluidextractum Caulophylli, 0.5 cc. (8 minims).

#### PODOPHYLLUM N.F. (PODOPHYLLUM)

**Synonyms.**—*Mandrake*, *May Apple*, Wild Lemon, Umbrella Plant, Vegetable Mercury; *Fr.* Rhizome de podophyllum; *Ger.* Fussblattwurz.



FIG. 164.—*Podophyllum peltatum*.

**Botanical Origin.**—*Podophyllum peltatum* Linné.

**Part Used.**—The dried rhizomes and roots.

**Standard of Assay.**—Podophyllum yields not less than 5 per cent of podophyllum resin.

**Limit of Impurities.**—Not more than 2 per cent. of acid-insoluble ash; not more than 2 per cent. of foreign organic matter.

**Habitat.**—Eastern and central North America.

**Plant.**—A perennial herb whose underground portion consists of a long, brown, jointed and branched rhizome bearing thick fibrous roots from the lower surface of its various nodes. Its aerial portion consists of two kinds of stems which arise from separate nodes of the rhizome. One of these, the flowering stem, bifurcates at its summit to form 2-stalked 5- to 7-lobed leaves from the fork of which arises a stalked, nodding, white flower. The other, the

flowerless stem, terminates in a peltate, 7- to 9-lobed leaf. The flower consists of 6 caducous sepals, 6 to 9 obovate white petals, 12 to 18 hypogynous stamens, a fleshy pistil with ovate ovary and sessile stigma. The fruit is an ovate berry about the size of a small lemon.

**Production and Commerce.**—The drug is collected in the spring or autumn. That which is collected in the spring yields the higher resin content. The rhi-



FIG. 165.—Colony of May Apple (*Podophyllum peltatum*) growing in an open area of woodland near Germantown, Pa.

zomes are dug up, washed, cut into cylindrical segments and carefully dried. The commercial supplies are chiefly obtained from plants growing wild in Virginia, North Carolina, Kentucky, Indiana and Tennessee.

**Description.**—In subcylindrical jointed pieces, usually showing a node and long internode region, from 4 to 20 cm. in length, the node being up to 15 mm., the internode up to 9 mm. in diameter, compressed above and below; externally dusky red to light yellowish-brown, smooth or slightly longitudinally wrinkled with somewhat V-shaped scars of scale leaves; some of the nodes annulate; upper surface of nodes marked with large deeply depressed, circular stem scars and sometimes with buds or stem-bases; lower surface of nodes, and at times portions of internodes adjacent to them, showing numerous white root scars or roots that may attain a length of 7 cm. and a thickness of 2.5 mm.; fracture, of both rhizome and root weak, brittle and even; internally, bark of rhizome grayish-white, of root white, wood of rhizome, showing a circle or ellipse or isolated yellowish-orange to pale yellow xylem masses, within which region



FIG. 166.—Two rhizome systems of *Podophyllum peltatum* Linné. Note prominent enlarged nodes with undeveloped buds and rootlets, and long internodes. At the anterior end of right hand system will be noted two young branches issuing from the distal node in furcate fashion.  $\times \frac{1}{2}$ .

is a large grayish-white pith, central region of root showing a pale yellow bundle; odor indistinct; taste disagreeably bitter and acrid.

**Microscopical Characteristics.**—Transverse sections made through the internode of the rhizome show the following structures:

1. *Epidermis* of reddish-brown cells with suberized outer and radial walls.

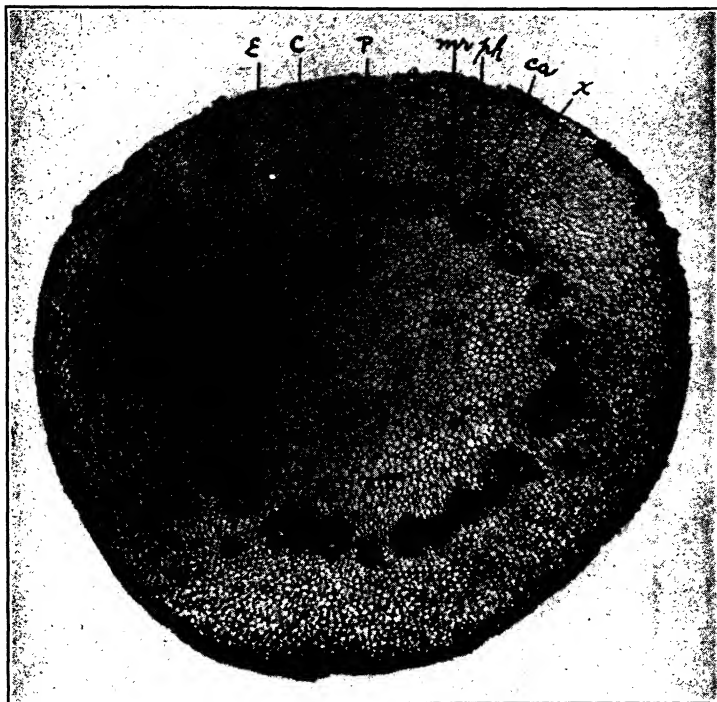


FIG. 167.—Transverse section cut through internode of *Podophyllum* rhizome showing epidermis (*e*); cortex (*c*); circle of fibrovascular bundles separated from each other by medullary rays, one of which is indicated by *mr*; phloem (*ph*), cambium (*ca*) and xylem (*x*) of a fibrovascular bundle; pith (*p*) filling up center of rhizome. Photomicrograph  $\times 20$ .

2. *Cortex* of about 20 layers of rounded cortical parenchyma cells containing numerous spheroidal, polygonal or 2- to 6-compound starch grains.
3. *Fibrovascular bundles* of the open collateral type 16 to 34 in number and arranged in an interrupted circle or an ellipse. Medullary-rays separate the bundles and unite the cortex with the pith.
4. *Pith*, a broad zone of parenchyma similar in nature to that found in the cortex.

Sections made through the nodes show the presence of rosette aggregates of calcium oxalate in certain of the parenchyma cells.

**Powdered Drug.**—Pale brown to weak yellow with a distinct odor; starch grains numerous, spheroidal, polygonal or 2- to 6-compound, the individual grains from 3 to  $20\mu$  in diameter; few crystals of calcium oxalate in rosette aggregates from 30 to  $80\mu$  in diameter; tracheæ with simple pores or spiral,



scalariform or reticulate thickenings; fragments of parenchyma containing starch, and reddish-brown to yellow suberized epidermal cells.

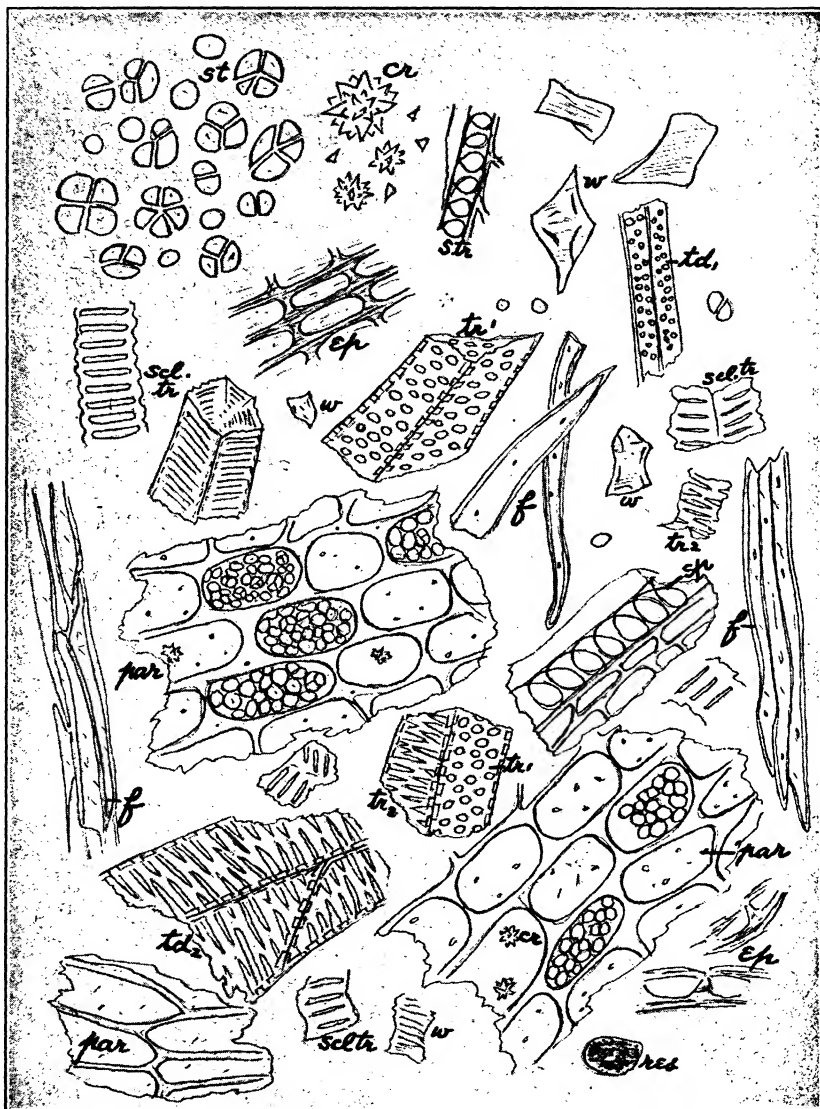


FIG. 168.—Powdered Podophyllum. *st*, starch; *cr*, rosette aggregates and crystal fragments of calcium oxalate; *ep*, suberized epidermal cells; *w*, cell wall fragments; *tr*<sup>1</sup>, pitted tracheae; *tr*<sup>2</sup>, reticulate tracheae; *scl tr*, scalariform tracheae; *str* and *sp*, spiral tracheae; *f*, wood fibers; *td*<sup>1</sup>, pitted tracheids; *td*<sup>2</sup>, reticulate tracheids; *par*, parenchyma; *res*, resin.

**Constituents.**—3.5 to 5 per cent. of resin composed of *podophyllotoxin* (about 20 per cent.) ( $C_{15}H_{14}O_6$ ), a purgative amorphous resin called *podophylloresin*; *picropodophyllin* and quercetin (a yellow coloring principle); podophyllic acid, starch, calcium oxalate, and gallic acid. Podophyllotoxin is gelatinized

by alkaline solutions forming podophyllic acid, a gelatinous substance, which loses water and becomes picropodophyllin, a crystalline non-toxic substance.\*

**Use.**—Cholagogue cathartic, chiefly in the form of Podophyllum Resin (*Podophyllin*) N.F. A suspension of Podophyllum resin (25 per cent) in mineral oil and an ointment containing the resin are employed for the removal of soft (venereal) warts.

**Average Dose.**—Of Resina Podophylli, 10 mg. ( $\frac{1}{6}$  grain).

**Preparations.**—Compound Colocynth and Jalap Pills, N.F., 1 pill; Compound Pills of Cascara (Hinkle's Pills), 1 pill.

**Adulterant.**—Powdered Podophyllum has been adulterated with guaiac wood. This may be detected by macerating 0.5 Gm. of the powdered material with 10 cc. of 90 per cent. alcohol and filtering, then adding a few drops of ferric chloride T. S. to the filtrate. The latter is colored deep blue.

**Allied Drug.**—*Rhizoma Podophylli Indici* or Indian Podophyllum Rhizome is obtained from *Podophyllum Emodi* Wallich, a perennial herb native to the lower slopes of the Himalayas of India and Afghanistan. It occurs as pieces of rhizomes and roots, the rhizomes being thicker than those of American Podophyllum, hard and fracturing with difficulty, exhibiting a brown horny or starchy fractured surface with radially elongated vascular bundles. Its constituents are similar to our native Podophyllum but its content of resin is greater, being 10 to 12 per cent., and its resin contains approximately twice the amount of podophyllotoxin as that of American Podophyllum. A good reagent to distinguish the resins of the Indian and American drugs is 5 per cent. aqueous solution of copper acetate which gives a bright green color and no brown precipitate with an alcoholic solution of *Podophyllum peltatum* resin and a brown precipitate and no green color with an alcoholic solution of *P. Emodi* resin.

#### MENISPERMACEÆ (MOONSEED FAMILY)

Choripetalous, woody, climbing, vines or rarely erect shrubs or small trees, mainly of the tropics or subtropics, with alternate, exstipulate, usually simple, often peltate leaves. Inflorescence in cymes or panicles or rarely the flowers solitary. Flowers small, green to white, unisexual, diœcious. Fruit a one-seeded succulent drupe. Seeds albuminous, often curved like a horseshoe. The stems in some genera show anomalous structure and the wood in cross section shows broad medullary rays. Calcium oxalate is found in the form of acicular crystals, rod-shaped prisms, solitary crystals and aggregates. Plants usually contain tonic, narcotic or poisonous bitter principles.

#### MENISPERMUM (MENISPERMUM)

**Synonyms.**—Canada Moonseed, Yellow Parilla.

**Botanical Origin.**—*Menispermum canadense* Linné.

**Part Used.**—The dried rhizome. The fresh root is official in the Homeopathic Pharmacopœia.

**Habitat.**—United States and Lower Canada on banks of streams.

\* In 1947, Hartwell of the National Cancer Institute isolated a white crystalline substance from Podophyllin as N.C.I. 1074 or *a-peltatin* which he reported to resemble picropodophyllin.

**Plant.**—A climbing vine springing from a horizontal rhizome, the latter attaining a length of about 2 m.; the aerial stem slender and bearing long petiolate, ovate-cordate or round-ovate leaves which are 3-7 angled or lobed; flowers greenish-white in axillary panicles; fruits bluish-black drupes, appearing like small grapes.

**Description.**—In segments of the rhizome of varying length with occasional long, slender, wiry rootlets. Rhizome horizontal, terete, from 3 to 20 mm. in diameter; externally yellow to dark brown, longitudinally wrinkled, with long internodes, the nodes bearing on their upper surface a circular stem scar or bud; branching wiry rootlets arising from all portions of the surface; fracture short in bark region; tough and fibrous in wood region; internally yellowish white, exhibiting a thin bark, a moderately broad wood and a broad pith; odor indistinct, taste bitter.

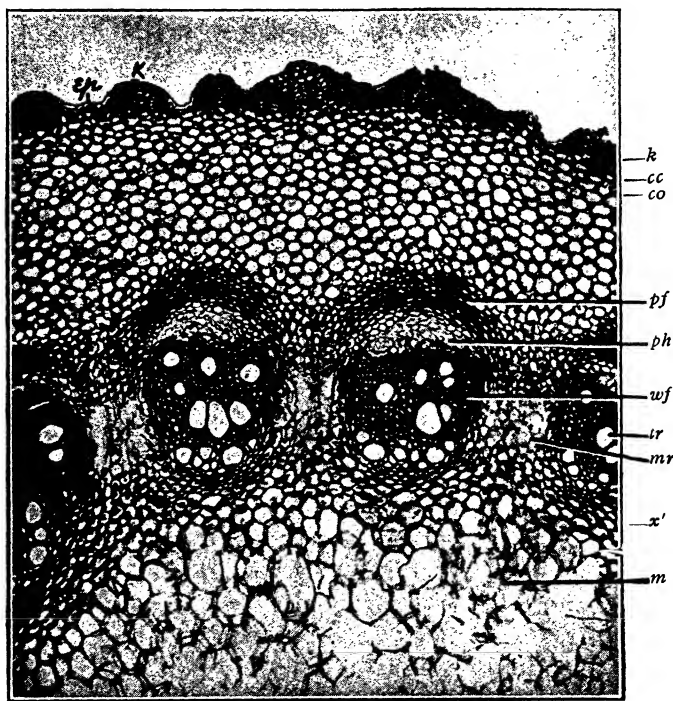


FIG. 169.—*Menispermum* rhizome. Photomicrograph of a representative portion of a transverse section. *ep*, epidermis; *k*, cork; *cc*, cork cambium; *co*, cortex; *pf*, pericyclic fibers; *ph*, phloem; *wf*, wood fibers and *tr*, trachea of xylem; *x'*, protoxylem; *mr*, medullary ray; *m*, pith. A cambium occurs between the light colored phloem and the darker colored xylem in each of the open-collateral bundles.

**Constituents.**—The alkaloid *menispermine*; starch, etc.

**Uses.**—Simple bitter and "alterative." Its value as an alterative is in doubt.

#### CALUMBA N.F. (CALUMBA)

**Synonyms.**—*Calumba* Root, *Columba*, *Colombo*; *Ger.* Kolombowurzel; *Fr.* Racine de Columbe.

**Botanical Origin.**—*Jateorhiza palmata* (Lamarck) Miers.

**Part Used.**—Dried root.

**Purity Rubric.**—Not more than 1 per cent. of foreign organic matter; it yields not more than 2.5 per cent. of acid-insoluble ash.

**Habitat.**—Mozambique and Madagascar. Cultivated in East Indies and Africa.

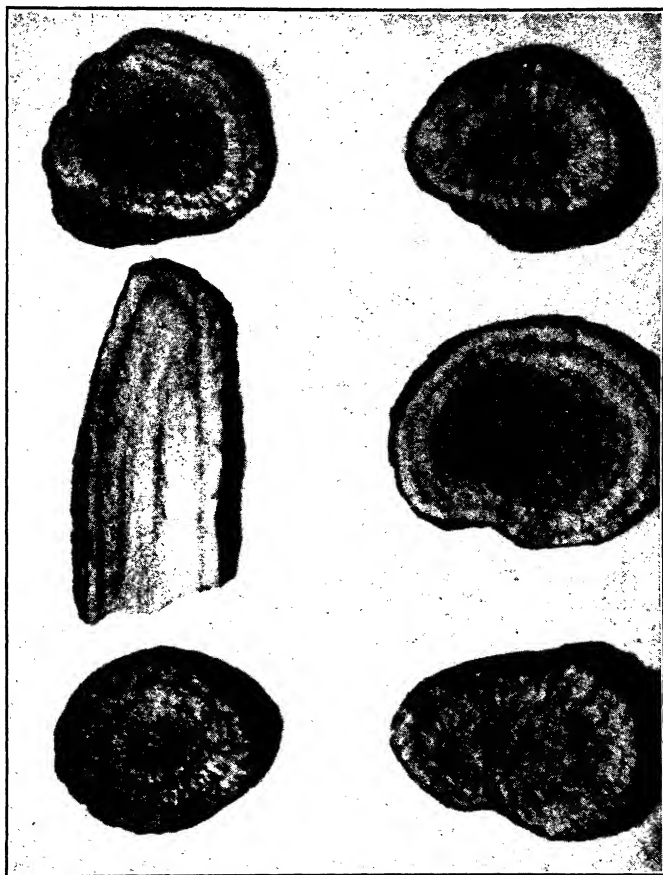


FIG. 170.—Calumba,  $\times \frac{1}{10}$ .

**Plant.**—A perennial climber clinging to trees in the forests of East Africa, Madagascar and other countries into which it has been introduced. Its leaves are simple, large and palmately 3- to 7-lobed. Its flowers are dioecious, small and inconspicuous and arranged in racemes, which are compound in the staminate plant and simple in the pistillate. The underground part consists of a short fibrous rhizome bearing numerous thick, fusiform roots.

**Production and Commerce.**—The underground portion is dug up in March, during dry weather; the thick roots are separated from the root-stock, cut into transverse slices and dried in the shade. It was formerly shipped from the

Portuguese possessions in Southeast Africa to India and thence to the world's markets. The drug is now imported into this country from Mozambique and British E. Africa. It is shipped in bags each containing about 1 cwt.

**Description.**—It occurs in circular or ovate transverse disks up to 10 cm. in diameter and seldom over 2 cm. in thickness, or in oblique or longitudinal slices up to 30 cm. in length. Externally, the marginal cork is pale reddish-

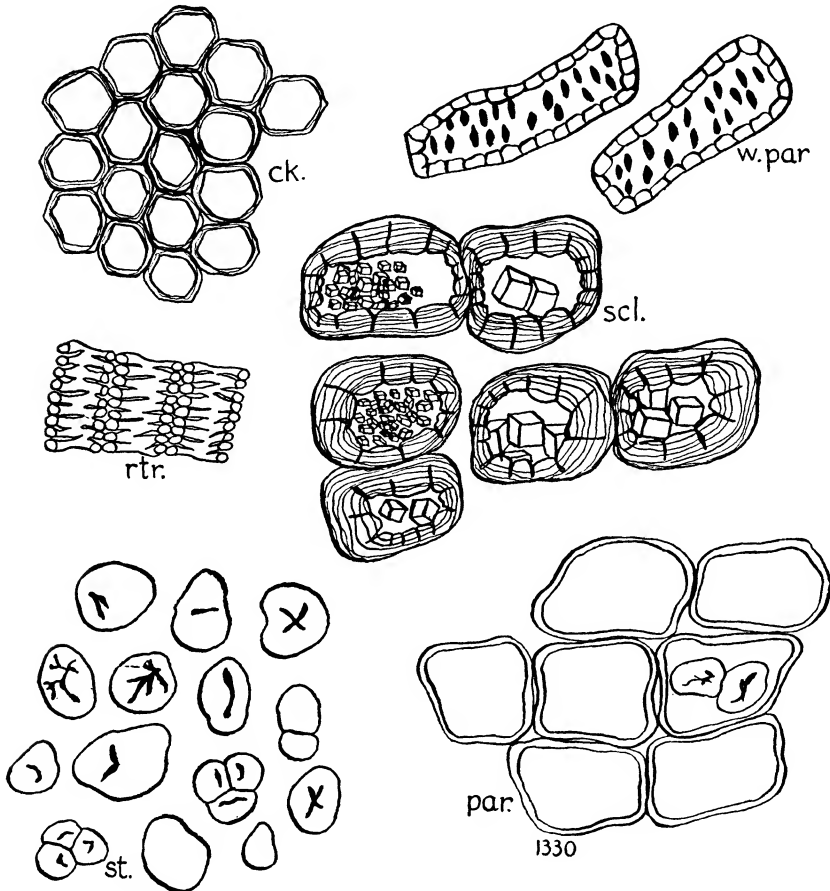


FIG. 171.—Powdered Calumba. *ck*, cork; *w.par*, wood parenchyma; *rtr*, reticulate tracheae; *scl*, stone cells containing calcium oxalate crystals; *st*, starch grains; *par*, starch-bearing parenchyma. (Drawn by J. Izzo.)

brown to light olive-brown and irregularly wrinkled, the cut surfaces weak yellowish-orange to moderate greenish-yellow, radiate and showing a distinct dark cambium in the outer portion and a depressed center. The fracture is short and mealy. The odor is slightly aromatic and the taste very bitter and slightly aromatic.

**Histology.**—Thin transverse sections when examined microscopically are characterized by the following peculiarities.

1. *Cork*, arranged in alternating layers of small and large cells and showing fissures extending into the next layer.

2. *Cork cambium* of 2 or 3 layers of tangentially-elongated meristematic cells.

3. A broad *cortex* composed of tangentially-elongated cortical parenchyma cells filled with ovoid, ellipsoidal or irregular starch grains. Among the outer cells of this region will be noticed *yellow stone cells* with irregularly thickened, lignified, porous walls and *containing calcium oxalate* either in the form of prisms or crystal sand (sphenoidal microcrystals).

4. *Open collateral fibrovascular bundles*, narrow and elongated, arranged in a circle and separated from each other by medullary-rays. The xylem portion of each bundle consists of tracheæ in small groups, separated from small groups of wood fibers by starch-bearing parenchyma, the latter abundant in the inner portion.

**Powdered Drug.**—Greenish-brown to grayish-yellow; numerous starch grains mostly single, occasionally 2- to 3-compound, the individual grains up to  $85\mu$  long, ovoid, ellipsoidal or irregular with an excentric, linear, X-shaped or branching hilum; stone cells few with irregularly thickened, porous walls and often containing one or more prisms of calcium oxalate up to  $30\mu$  in length or numerous microcrystals; fragments of tracheæ with bordered pores and reticulate markings associated with wood fibers having long, oblique, slit-like pores, and few fragments of lignified wood parenchyma, the last having large pores.

**Constituents.**—The yellow alkaloids, *columbamine*, *jateorhizine* and *palmatine*; the bitter principles *columbin* and *chasmantherin*; starch, calcium oxalate etc. Tannin is absent.

**Use.**—Columba is used chiefly as a simple bitter. It has been extensively used in veterinary preparations.

**Average Dose.**—1 Gm. (15 grains).

**Preparations** (in N.F. VII).—Fluidextractum Calumbæ, 1 cc.; Tinctura Calumbæ, 4 cc.

**Adulterants and Substitutes.**—1. *Columba rhizome*, occurring in deeper colored disks up to 3 cm. in width and more woody and radiate than the root.

2. *Ceylon Columba*, the root of *Coscinum fenestratum* (Fam. *Menispermaceæ*), the slices of which are dark yellow, more woody and not depressed in the center.

#### PAREIRA (PAREIRA)

**Synonyms.**—Pareira Brava, Velvet Leaf; *Fr.* Butua; *Ger.* Grieswurz.

**Botanical Origin.**—*Chondodendron tomentosum* Ruiz et Pavon.

**Part Used.**—The dried root.

**Purity Rubric.**—It contains not more than 5 per cent. of its stems or more than 2 per cent. of other foreign organic matter (N.F. V).

**Habitat.**—Brazil and Peru.

**Plant.**—A perennial dioecious climber with stem attaining a thickness of up to 10 cm. and with rough bark covered with watery protuberances. The leaves are long petioled, ovate, cordate, smooth on upper surface but tomentose with

an ashy hue on lower surface. The inflorescence is a panicle of small flowers. The fruit is a purplish-black, one-seeded, oval drupe, occurring in bunches of 6.

**Production and Commerce.**—The plants grow wild in various parts of Brazil and Peru where they are known as *Abutua* or *Butua*. They are particularly abundant on the hills separating the Copacabana from the basin of the Rio de Janeiro. The roots are dug at various seasons of the year, cut into transverse segments and dried. They are shipped to the various markets of the world from Rio de Janeiro and Bahia, Brazil.



FIG. 172.—*Pareira*.  $\times \frac{1}{4}$ .

**Description.**—The drug occurs on the market in heavy segments of variable length and from 0.5 to 6 cm. in diameter. The segments are cylindrical, more or less tortuous; externally brownish-black or blackish-brown with transverse ridges or knot-like projections, occasionally fissured and furrowed or longitudinally wrinkled; hard and tough; having a waxy luster when recently cut; the transverse surfaces exhibiting several successive eccentric and distinctly radiate concentric zones of projecting fibrovascular bundles, separated from each other by concentric zones of parenchyma and stone cells; odor indistinct; taste bitter. An infusion of the drug turns bluish-black with tincture of iodine.

**Histology.**—Transverse sections of the root, examined under the microscope, show the following peculiarities, passing from periphery toward the center:

1. *Cork*, consisting of several layers of suberized cells with brown contents.
2. *Cork cambium* of meristematic cells.
3. *Cortex* of several layers of parenchyma cells containing simple or 2-4-compound starch grains.
4. Several concentric zones of *open collateral fibrovascular bundles* alternating with zones of parenchyma containing starch. Each fibrovascular bundle

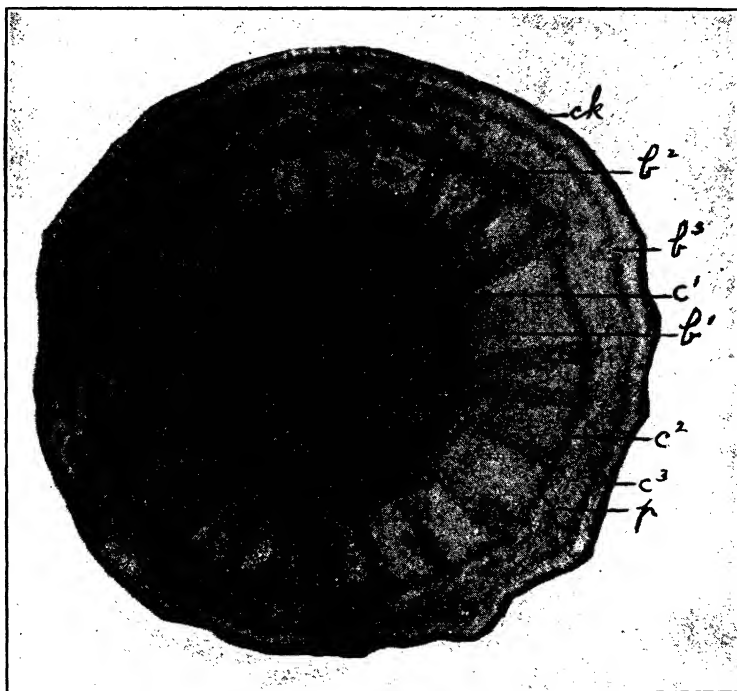


FIG. 173.—Transverse section of Pareira. Cork (*ck*); cambium (*c¹*) which originated first series of bundles (*b¹*); cambium (*c²*) which originated second series of bundles (*b²*); cambium (*c³*) giving rise to third series of bundles (*b³*), the last only slightly developed; parenchyma of cortex (*p*).

exhibits an outer semicircular phloem composed of sieve tissue and phloem parenchyma, a somewhat collapsed cambium and a radially elongated xylem composed of wide tracheæ surrounded by wood fibers. The fibrovascular bundles are separated from each other by broad medullary-rays whose cells contain abundant starch. Each circular zone of parenchyma shows on its inner face a nearly closed ring of stone cells, the walls of which are thick and porous.

**Constituents.**—A bitter alkaloid, *pelosine* (bebeerine) which is soluble in benzene, a crystalline and an amorphous alkaloid insoluble in benzene, starch, tannin, wax, etc. Scholtz and Faltis have shown that commercial bebeerine sulphate consists of at least 5 alkaloids, viz.: Bebeerine, isobebeerine,



$\beta$ -bebeerine, bebeerine- $\beta$  and chondrodine. Bebeerine is also found in Bebeeru bark obtained from *Ocotea Rodiæi* (R. Schomburk) Mex. (*Nectandra Rodiæi* Hook.) (Fam. *Lauraceæ*). *d-tubocurarine* has been isolated from the Pareira plant, the latter and a related species, *Chondodendron polyanthium*, representing the chief sources of medicinal *Curare*.

**Uses.**—Pareira has been used in chronic inflammations of the urinary tract, as a diuretic, and as a bitter tonic. Curare is used to induce muscular relaxation and in the diagnosis of myasthenia gravis.

**Average Dose.**—2 Gm. (30 grains). Dose of fluidextract, 2 to 4 cc.

**Substitutes and Adulterants.**—1. The roots and stems of *Cissampelos Pareira* L. (Fam. *Menispermaceæ*), frequently called "False Pareira" and found growing in the West Indies and South America, has been the most common substitute for the genuine article. The roots of this plant are dark brown in color externally, light brown internally, show but one circle of fibrovascular bundles and are devoid of a waxy luster when cut. The stems are in long cylindrical segments, some of which, in having trailed along the ground, show rootlets at the nodes. They are usually less than an inch in diameter, have light-brown bark showing longitudinal or spiral shallow furrows and wrinkles, a coarse fibrous fracture and no concentrically arranged bundles. Both roots and stems are bitter but devoid of astringency. An infusion of "False Pareira" is not colored bluish-black with iodine.

2. Stems of *Chondodendron tomentosum* Ruiz et Pavon are often admixed with the roots or occasionally entirely substituted for the genuine article. These are of varying length, 1 to 4 inches in diameter, grayish in color, and show concentrically arranged series of bundles like the root, but differ from it in exhibiting a distinct pith, a tendency of the bundles to separate, in being frequently partially covered externally with foliaceous lichens bearing black apothecia and in the absence of a waxy luster of their cut surfaces. Some segments have stumps of roots springing from them.

### COCCULUS (COCCULUS)

**Synonyms.**—Cocculus Indicus, Fish Berry, Indian Berry, Levant Berry; *Ger.* Kockelskörner, Fishkörner; *Fr.* Coque du Levant.

**Botanical Origin.**—*Anamirta Cocculus* (Linné) Wight et Arnott (*A. paniculata* Colebrooke).

**Part Used.**—The dried ripe fruit.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—Eastern India and the Malay Archipelago.

**Plant.**—A perennial, dioecious, woody climber bearing alternate, cordate, pinnately-veined leaves and axillary, pendulous panicles of small flowers. The fruit is a red drupe of reniform outline containing an urn-shaped seed.

**Production and Commerce.**—The fruits are collected, when ripe, from wild plants by the natives and dried in the sun. In India, Ceylon and the East Indies they have been used to stupefy fish after which the fish are readily caught

by hand. Most of the product is sent to Calcutta, Madras and Bombay from which it is shipped to London and the United States.

**Description.**—Drupe dusky reddish-brown to moderate brown, reniform and wrinkled; 8 to 13.5 mm. in length and 7 or 11 mm. in breadth and 7 to 10 mm. in thickness, the base marked by a circular stem scar; pericarp tough, about 1 mm. in diameter, enclosing a single seed; seed yellowish-gray, urn-shaped, its longitudinal and cross sections crescent-shaped; odor indistinct; taste bitter, the seed intensely bitter.

**Microscopical Characteristics.**—

**I. Pericarp:**

1. Epicarp of a layer of more or less cubical-shaped cells.
2. Mesocarp consisting of an outer region of thin-walled cells with brown granular contents which become reddish-brown with solution of potassium

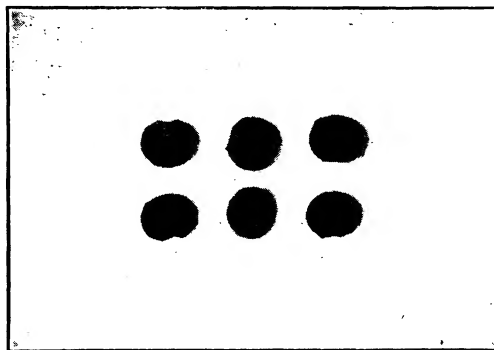


FIG. 174.—Fish Berries,  $\times 42$ . (Photograph by Stoneback.)

hydroxide, a zone of elongated brownish-red cells through which course fibro-vascular bundles; several rows of yellowish cells.

3. Endocarp of strongly lignified, porous, sclerenchyma fibers.

**II. Seed:**

1. Endosperm composed of polygonal cells with thin walls containing aleurone and fixed oil and acicular crystals insoluble in KOH solution, alcohol or water, soluble in HCl.

2. Embryo.

**Powdered Drug.**—Moderate yellowish-brown. The diagnostic histological elements are: numerous thick-walled, porous, yellow sclerenchyma fibers, and thin-walled cells of the endosperm containing fixed oil, aleurone grains up to  $50\mu$  in length and acicular crystals, the latter soluble in diluted hydrochloric acid and insoluble in water, alcohol and potassium hydroxide T.S. The taste is very bitter.

**Constituents.**—A bitter, crystalline neutral principle termed "*picrotoxin*" (1.5 per cent.) which has been separated into *picrotoxinin* ( $C_{15}H_{16}O_6 \cdot H_2O$ ) and *picrotin* ( $C_{16}H_{18}O_7$ ). Picrotoxin is a poison producing convulsions which is found in the seeds; the alkaloids menispermine and paramenispermine, found in the fruit wall; fat, resin, gum, etc.

**Use.**—Parasiticide in pediculosis, usually in the form of the tincture.

**Preparation.**—Tinctura Cocculi, N.F. VII.

**Picrotoxin (Picrotoxinum) U.S.P.** or *Cocculin* is an active principle obtained from the seed of *Anamirta Cocculus* (Linné) Wight et Arnott (Fam. *Menispermaceæ*). It occurs as flexible, shining prismatic crystals or as a microcrystalline powder; odorless but affected by light. 1 Gm. dissolves in about 350 cc. of water.

It should be stored in closed, light-resistant containers.

**Use.**—In poisoning by barbiturates. Av. dose, Intravenous. To be determined by the physician (usually 2 mg. ( $\frac{1}{30}$  gr.) or more, depending upon the severity of the poisoning).

**Preparation.**—Picrotoxin Injection (Injectio Picrotoxini) U.S.P.

#### MONIMIACEÆ (MONIMIA FAMILY)

Tropical aromatic shrubs and trees with opposite coriaceous leaves and cymose inflorescences. The plant axis and leaves contain cells or internal glands with aromatic hydrocarbon contents. Glandular hairs are absent, the non-glandular type common. Calcium oxalate occurs in some members as acicular or rhombohedral crystals. Cystoliths occur in *Peumus*.

#### BOLDUS (BOLDO)

**Synonym.**—Boldo Leaves.

**Botanical Origin.**—*Peumus Boldus* Molina [*Boldu Boldus* (Molina) Lyons].

**Part Used.**—The dried leaf.

**Purity Rubric.**—Not more than 2 per cent. of its stems or other foreign organic matter and not more than 6 per cent. of acid-insoluble ash (N.F. V).

**Habitat.**—Mountainous districts of Chile.

**Plant.**—A dioecious evergreen shrub bearing opposite, ovate to ellipsoidal coriaceous leaves and cymose flowers.

**Description.**—Lamina broadly ovate or ellipsoidal, from 3 to 7 cm. in length and from 1 to 5 cm. in breadth, the base varying from rounded to very slightly indented; the apex varying from acute to rounded to slightly emarginate, the margin entire and sharply revolute; thick, coriaceous, rigid and brittle; from pale green to brownish-green, papillose, roughened on both surfaces, the principal veins coarsely reticulate, impressed above, prominent underneath, the petiole stout and rigid from 1 to 6 mm. in length, reticulate; odor peculiar; when crushed very strong and somewhat resembling oil of chenopodium; taste bitter, warm and pungent, camphoraceous and slightly terebinthinate.

**Histology.**—Transverse sections of the lamina show the following microscopic characteristics:

1. *Upper epidermis* of clear tangentially-elongated cells with thick, more or less wavy, outer cuticle and thick walls and pits from the base of which groups of unicellular, thick-walled hairs emerge.

2. *Hypodermis* of usually 2 layers of clear elongated cells.

3. *Palisade parenchyma* of 2 layers of columnar, chloroplast-containing cells. In this region there occur spheroidal internal glands with hydrocarbon contents.

4. *Spongy parenchyma* of small irregularly rounded and elongated cells and large intercellular-air-spaces in which cystoliths are frequently observed.

5. *Lower epidermis* of a layer of clear tangentially-elongated cells and stomata. In this epidermis pits are found which lodge groups of unicellular, thick-walled trichomes (stellate hairs).

**Constituents.**—An alkaloid termed *boldine*; a glycoside, occurring as a syrupy yellow liquid, and called *boldoglucin*; 2 per cent. of *volatile oil*; tannin and resin.

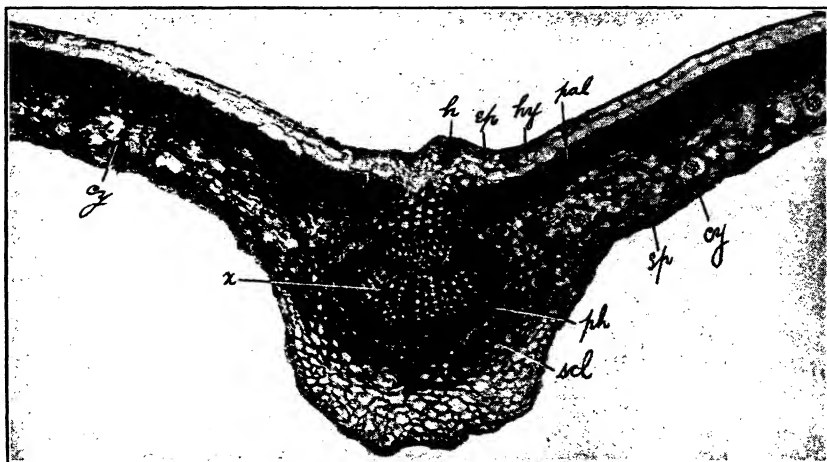


FIG. 175.—Boldo leaf as observed in a transverse section. Base of hair (*h*); epidermis (*ep*); hypodermis (*hy*); palisade parenchyma (*pal*); spongy parenchyma (*sp*); cystoliths (*cy*); xylem (*x*); phloem (*ph*); and arc of sclerenchyma fibers in pericycle (*scl*).

**Uses.**—Aromatic stimulant, diuretic; hepatic stimulant in jaundice and cholelithiasis.

**Average Dose.**—0.5 Gm. (8 grains).

**Preparation** (unof.).—Fluidextract, 5 to 10 *m*.

#### LAURACEÆ (LAUREL FAMILY)

Aromatic trees or shrubs with alternate, coriaceous, pellucid punctate leaves containing considerable volatile oil. The flowers are polygamous with a petaloid calyx of 4 to 6 sepals and perigynous stamens, having anthers that dehisce by 2 to 4 recurved valves. The fruit is a drupe or berry. Represented by the Sassafras, Spice Bush, Red Bay, Pond Spice, Cinnamon and Camphor trees. Among the histological peculiarities of this family might be noted the following: Non-glandular unicellular hairs, acicular or spindle-shaped crystals of calcium oxalate, numerous secretion sacs containing either oil or mucilage and distributed through all parts of the plant.

## SASSAFRAS N.F. (SASSAFRAS)

**Synonyms.**—*Sassafras Bark*, Ague Tree, Saxifrax, Cinnamon Wood; *Ger.* Sassafrasrinde; *Fr.* Ecorce de Sassafras.

**Botanical Origin.**—*Sassafras albidum* (Nutt.) Nees [*Sassafras variifolium* (Salisb.) O. Kuntze].

**Part Used.**—The dried bark of the root.

**Standard of Assay.**—Sassafras yields not less than 4 cc. of sassafras oil from each 100 Gm. of drug.

**Limit of Impurities.**—It contains not more than 4 per cent. of adhering wood, outer corky tissues or other foreign organic matter; it yields not more than 5 per cent. of acid-insoluble ash.

**Habitat.**—United States in rich woods from Kansas eastward.

**Plant.**—A tree, 4 to 30 m. high, with spicy aromatic bark and green to greenish-yellow twigs. The leaves show heterophylly, being entire, ovate, or 2- to 3-lobed. The flowers are small, greenish-yellow and appear in the spring on several flowered racemes. The fruit is a blue ovoid drupe borne on the end of a thick reddish pedicel.

**Production and Commerce.**—The bark is gathered in the early spring or autumn, deprived of the outer corky layers and dried. The commercial supplies come largely from Virginia, Tennessee and Kentucky. The official oil of sassafras (U.S.P.) is distilled from the entire root. Much of it at present is produced from sassafras stumps purchased from farmers by distillers in the south, principally in Kentucky. The stumps are reduced to small chips and the distillation conducted in large retorts. The root bark yields from 6 to 9 per cent. of volatile oil, whereas the stumps yield averagely only about 1 per cent. Most of the oil is used by manufacturers of soft drinks.

**Description.**—In irregularly transversely curved or quilled pieces deprived of the grayish-brown cork, of variable length and from 1 to 4 mm. thick; outer surface weak reddish-brown to light yellowish-brown, nearly smooth and showing irregular ridges; inner surface light brown to moderate brown, finely striated; fracture short, brittle, the fractured surface showing a light brown cortical layer and a pale orange to reddish-brown inner bark; odor aromatic; taste slightly mucilaginous, astringent, aromatic and pungent.

**Histology.**—Under the microscope transverse sections of the drug mounted in water exhibit the following structures:

1. *Cortex* (secondary) composed of numerous layers of irregularly rounded parenchyma cells, some of which contain single or 2- to 4-compound starch grains and others yellowish-red tannin masses that become bluish-black with ferric chloride test solution. Scattered among the parenchyma cells will be noted numerous secretion sacs containing globules of oil or, at times, mucilage. Occasionally patches of cork cells may be found adhering to the outer margin of the cortex, due to imperfect peeling of bark. These cells appear tabular and are arranged in regular rows.

2. A broader *phloem* separated into numerous phloem patches by wavy phloem-rays. Each phloem patch is composed of broader polygonal sieve

tubes and narrower phloem parenchyma, interspersed among which are numerous isolated, angular, strongly lignified bast fibers and secretion sacs containing oil or mucilage. The phloem parenchyma cells and the phloem-ray cells contain either starch or orange colored tannin masses.

**Powdered Drug.**—Yellowish-brown to light reddish-brown and showing the following histological elements: 1. Spindle-shaped bast fibers often irregular in

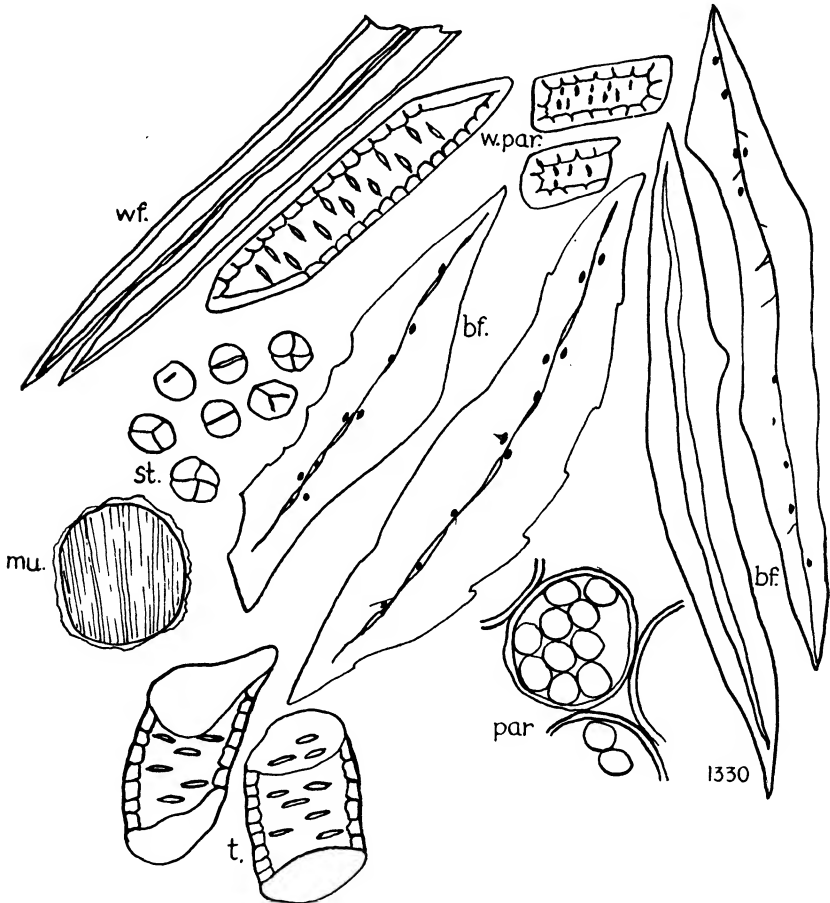


FIG. 176.—Powdered Sassafras. *bf.*, bast fibers; *par.*, starch-bearing parenchyma; *st.*, starch grains; *mu.*, secretion cell containing mucilage or volatile oil; *wf.*, wood fibers, *w.par.*, wood parenchyma, and *t.*, pitted tracheæ from adherent wood. (Drawing by J. Izzo.)

outline with sharply pointed ends, up to  $400\mu$  long, about  $25\mu$  in diameter, and with very thick, strongly lignified walls, the lumina often nearly obliterated.

2. Simple or 2- to 4-compound starch grains, the separate grains being spheroidal or polygonal and often with a cleft, up to  $20\mu$  in diameter, some of the grains swollen or altered and up to  $30\mu$  in diameter. 3. Fragments of parenchyma, some of the cells containing irregular orange-colored tannin masses, others starch grains and still others oil globules. 4. Fragments of thin-walled, porous tracheæ

associated with thin-walled wood fibers, these due to wood that frequently adheres to the bark.

**Constituents.**—*Volatile oil* (6 to 9 per cent.) containing *safrol*; tannin, sassafrid, starch, etc. The wood of the root contains less than 1 per cent. of oil.

**Uses.**—Aromatic, stimulant, diaphoretic, flavoring agent.

**Average Dose.**—10 Gm. ( $2\frac{1}{2}$  drachms), of oil, 0.1 cc. ( $1\frac{1}{2}$  minims).

**Preparations.**—Fluidextractum Sarsaparillæ Compositum, 2 cc.; Syrupus Pini Albæ Compositus, 4 cc.; Syrupus Pini Albæ Compositus cum Codeina, 4 cc.

**Adulterants.**—The bark of the stem of the same plant has often been found admixed with the root bark. It is distinctly fissured on the outer surface, less aromatic and more mucilaginous than the latter. When examined under the microscope, unlike the root bark, it shows bast fibers in groups, stone cells, and a large number of cells in the cortex that contain chloroplastids. Excess adherent wood and pieces of roots have frequently occurred in the commercial drug.

**Sassafras Oil U.S.P. (Oleum Sassafras)** represents the volatile oil distilled with steam from the root of *Sassafras albidum*. It is a yellow to reddish-yellow liquid with an odor and taste of sassafras, soluble in 2 volumes of 90 per cent. alc.; sp. gr. 1.065 to 1.077 at 25°C.; refractive index 1.5250 to 1.5350 at 20°C.; opt. rot. +2 to +4 in a 100 mm. tube at 25°C. It contains about 80 per cent. of *safrol*, about 10 per cent. of *pinene* and *phellandrene* and about 0.5 per cent. of *eugenol*. It is used as a flavoring agent, in the preparation of sassafras tea, as a repellent for ants and as an antiseptic in nasal and throat sprays.

**Preparations.**—In U.S.P.: Compound Sarsaparilla Syrup. In N.F.: Aromatic Eridictyon Syrup.

**Allied Product.**—**Brazilian Sassafras Oil** is the volatile oil distilled from the wood of *Ocotea pretiosa* Benth. (Fam. *Lauraceæ*), a tall tree native to South America and growing abundantly in the State of Santa Catarina, Brazil, where the oil is commercially produced in large amounts. This oil possesses a high safrol content. It is used largely as a source of safrol which is converted into heliotropine in the perfuming of soaps, disinfectants, deodorants, sprays, etc.

#### CINNAMON U.S.P. (CINNAMOMUM)

**Synonyms.**—Cinnamomum Saigonicum, *Saigon Cinnamon*, Saigon Cassia, Annam or China Cinnamon; *Ger.* Saigonzimmt; *Fr.* Cannelle de Saigon.

**Botanical Origin.**—*Cinnamomum Loureirii* Nees.

**Part Used.**—The dried bark.

**Standard of Assay.**—Cinnamon yields, from each 100 Gm., not less than 2.5 cc. of oil of cinnamon.

**Limit of Impurities.**—Not more than 2 per cent of foreign organic matter.

**Habitat.**—China and Japan.

**Commercial Source.**—Saigon, in French Cochin China.

**Plant.**—A glabrous evergreen tree of medium height with opposite or alternate, elliptic or oblong, short petioled, strongly 3-nerved, coriaceous leaves with acuminate apex. The small yellow flowers are perfect with a short tubed peri-

anth of 6 segments surrounding 3 rows of perfect stamens, a circle of staminodes and a central pistil. The fruit is a small berry enclosed in a cup-shaped perianth.

**Description.**—In single and double quills up to 30 cm. in length and 4 cm. in diameter, the bark from 0.5 to 7 mm. in thickness, or in broken irregular pieces or in flattened slabs up to 10 mm. in thickness; outer surface light brown to dark purplish-brown, often with grayish patches of crustose lichens and numerous bud scars; finely longitudinally wrinkled when from young twigs, rough from corky patches surrounding the lenticels when from older stems; inner surface reddish-brown to dark brown, granular and slightly striate; fracture short; inner

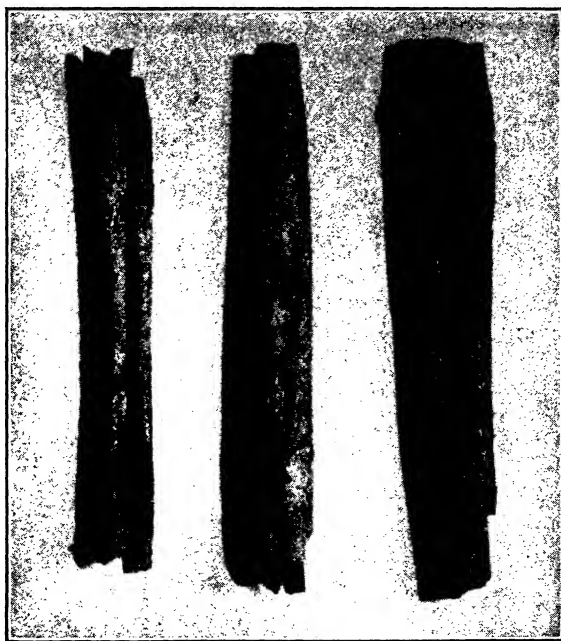


FIG. 177.—Saigon Cinnamon,  $\times \frac{1}{4}$ .

bark porous; odor characteristic and aromatic; taste sweetish, strongly aromatic and pungent.

**Histology.**—Sections of the older stem bark show the following microscopic peculiarities: (Fig. 178).

1. *Cork*, composed of several layers of more or less lignified cork cells.
2. *Cork cambium* of somewhat collapsed cells.
3. *Cortex* composed of several layers of more or less flattened parenchyma cells with brown walls, many of which contain starch grains. Scattered about in this region are colorless stone cells containing a reddish-brown amorphous substance and frequently starch, and some oil and mucilage cells.
4. *Pericycle*, a nearly continuous zone several layers in width, of stone cells among which are small groups of pericyclic fibers with thickened and slightly lignified walls. These contain reddish-brown contents.



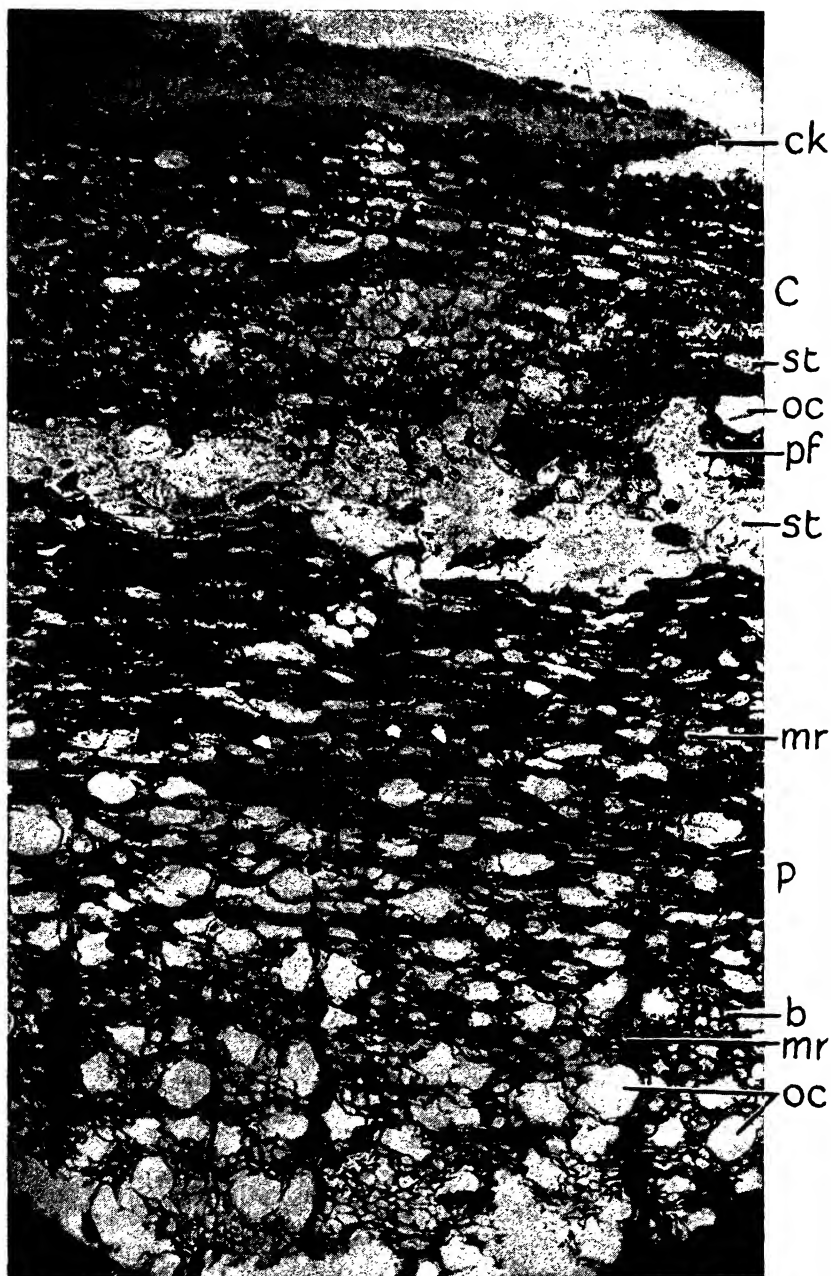


FIG. 178.—Saigon Cinnamon. Photomicrograph of cross section of bark,  $\times 50$ . *ck*, cork; *c*, cortex; *pf*, pericyclic fibers in pericycle; *st*, stone cells; *p*, phloem; *b*, bast fibers; *mr*, medullary rays; *oc*, oil cells.

5. *Phloem*, a broad zone traversed by medullary-rays averagely 1 to 3 cells wide, which divide this region into a number of more or less oblong, radial phloem patches. Each of these shows islets of somewhat collapsed sieve tissue, isolated bast fibers (which like the stone cells contain an amorphous, reddish-

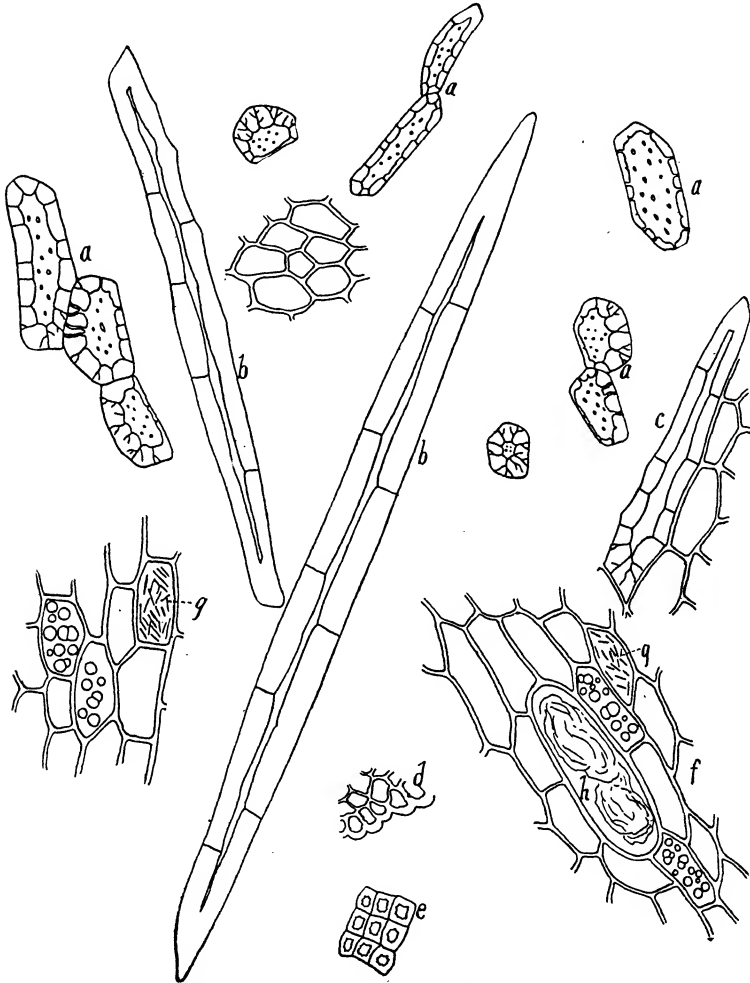


FIG. 179.—Powdered Cinnamon. Saigon. (a) Stone cells; (b), (c), sclerenchyma fibers; (d) epidermis, lateral view; (e) epidermis, vertical view; (f) parenchyma, longitudinal view with crystal bearing cell (g), resin cell (h) and starch. (After Schneider.)

brown substance), and phloem parenchyma, the latter usually filled with single and compound starch grains or occasionally with thin, short raphides of calcium oxalate.

The secretion cells are large and more abundant than in *Cassia*, *Batavia* and *Ceylon* cinnamons. **Young twig bark** shows an epidermis with a thick, yellow cuticle, fewer stone cells in the pericycle and a narrower phloem with fewer secretion cells than in the older bark.

**Powdered Drug.**—Yellowish-brown or reddish-brown; numerous single and compound starch grains, the individual grains spheroidal, plano-convex or polygonal and up to  $25\mu$  in diameter; fragments with stone cells, the lumina frequently containing a reddish-brown amorphous substance and starch grains; sclerenchyma fibers from  $300$  to  $1500\mu$  in length, usually in groups with very thick, more or less wavy and slightly lignified walls; fragments of lignified



FIG. 180.—Ceylon Cinnamon,  $\times \frac{1}{2}$ .

cork cells; parenchyma cells with reddish-brown walls; oil cells and mucilage cells often imbedded in parenchyma.

**Constituents.**—*Volatile oil* (2 to 6 per cent.) containing *cinnamic aldehyde*; *mannitol*, starch, resin, *tannin*, mucilage, calcium oxalate, etc.

**Average Dose** (unof.).—0.25 Gm. (4 grains).

**Uses.**—Aromatic-astringent in nausea, carminative, and flavoring agent.

**Preparations.**—In N.F.: Aromatic Powder, 1 Gm.; Aromatic Chalk Powder, 2 Gm.; Cinnamon Tincture, 1 cc.; Compound Gambir Tincture, 2 cc.

CEYLON CINNAMON N.F. (CINNAMOMUM ZEYLANICUM)

**Synonyms.**—True Cinnamon, Cortex Cinnamomi, *Ger.* Zeylonzimmt; *Fr.* Cannelle de Ceylon.

**Botanical Origin.**—*Cinnamomum zeylanicum* Nees.

**Part Used.**—The dried inner bark of the shoots of coppiced trees.

**Standard of Assay.**—Not less than 0.5 cc. of volatile Ceylon cinnamon oil from each 100 Gm. of the drug.

**Limit of Impurities.**—*Foreign organic matter:* not more than 2 per cent. *Other cinnamons:* The powdered drug contains not more than a trace of lignified cork cells, few starch grains exceeding  $10\mu$  in diameter and no fibers over  $30\mu$  in breadth. *Acid-insoluble ash:* Not more than 2 per cent.

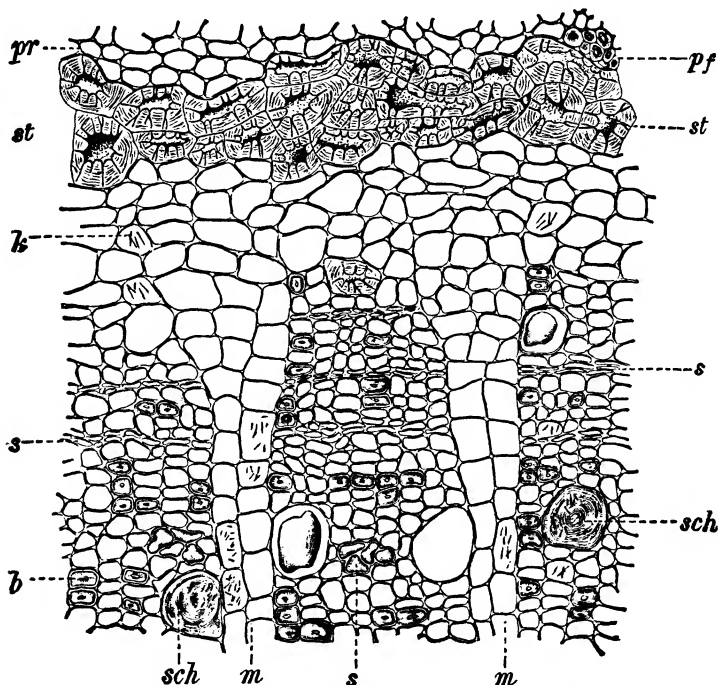


FIG. 181.—Ceylon Cinnamon. Transverse section, showing parenchyma (*pr*), pericyclic fibers (*pf*) and stone cells (*st*) of pericycle; medullary rays (*m*) of phloem containing short, thin raphides of calcium oxalate (*k*); sieve tubes (*s*), bast fibers (*b*) and secretion cells containing volatile oil or mucilage (*sch*). (After Greenish, "Microscopical Examination of Foods and Drugs.")

**Habitat.**—Ceylon.

**Plant.**—A tree with ovate to lance-ovate, 3- to 5-nerved, evergreen, coriaceous, aromatic leaves which are shiny green on the upper surface, glaucous and reticulate beneath. The flowers are small, yellowish-white and arranged in loose, silky clusters.

**Production and Commerce.**—The bark is chiefly obtained from plants which are cultivated in Ceylon in such a way that they develop slender shoots with little or no astringent cork. The principal areas of production are along Ceylon's western seacoast from Negombo to Matara, the total yearly plantings averaging about 25,000 acres. The seed is sown in a nursery by planting 8 seeds to a hole, watering and shading. In about 6 months the young plants are set

out in the field about 6 ft. apart and grown for about 3 years, being pruned to grow straight. The young stems are then cut down to a few inches above the ground, and allowed to form stools from which spring adventitious buds (*coppicing*). These develop into adventitious shoots which lengthen at the rate of about a meter a year. When the shoots are about  $1\frac{1}{2}$  to 2 meters long, they are cut down during the rainy season and brought to a shed where they are deprived of leaves and small twigs. The outer bark is then scraped off with curved knives as far as the pericyclic fibers, or outermost region of the inner bark. Longitudinal incisions from 6 to 8 in. in length are then made through the soft inner bark to the cambium line and the inner bark carefully removed from the hard wood as tubes or quills. A long stick of compound quills is then formed by placing congeries of from 7 to 12 or more soft white quills together to form a tube about a yard in length and then rolled by hand, placed on mats and allowed to dry successively for 3 days in the sun and 3 days in the shade. To prevent swelling and splitting of the quills during the drying process, the quills are rolled by hand and slightly pressed daily. During the drying, the original white color of the bark turns to a yellowish brown or weak orange color. The quills are then usually made into bundles that are tied with split bamboo and exported in cylindrical bales from Colombo or Calcutta to the markets of the world.

**Description.**—In closely rolled congeries of quills, composed of from 7 to 12 or more thin layers or inner bark, up to about 1 meter in length, the bark up to 1 mm. in thickness; outer surface light yellowish-brown to weak orange, smooth, longitudinally striate and showing circular or irregular brownish patches, occasionally with perforations that indicate the positions of the nodes; inner surface light yellowish brown to weak orange with faint longitudinal striæ; fracture short and splintery with projecting fibers; odor delicately aromatic; taste sweetish and warmly aromatic.

**Histology.**—Sections of this bark exhibit the following inner structure:

1. *Pericycle*, containing an almost continuous band of stone cells among which are small groups of pericyclic fibers with thick, though slightly lignified walls.

2. *Phloem*, a broad zone traversed by medullary-rays averagely 1 to 2 cells wide and containing either starch and raphides of calcium oxalate. The parenchyma cells of each phloem patch contain ether starch, raphides, or reddish-brown contents. Scattered among these are bast fibers that are either isolated or in small groups, oil cells and mucilage cells.

**Powdered Drug.**—Light brown or light yellowish-brown; simple or 2- to 4-compound starch grains, the separate grains spheroidal, plano-convex or polygonal, mostly under  $10\mu$  in diameter; bast fibers mostly single, with thick walls and of spindle shape; numerous stone cells up to  $150\mu$  in diameter with colorless walls, occasionally with one wall thinner than the others, their lumina with reddish-brown and occasionally starch grain contents, the stone cells averagely longer and more uniformly thickened than in Saigon cinnamon; nearly colorless pericyclic fibers and slightly lignified bast fibers from 300 to  $800\mu$  in

length and up to  $30\mu$  in diameter, spindle-shaped and having thick, more or less wavy, porous walls; elongated secretion cells with volatile oil or mucilage contents; fragments of phloem parenchyma tissue with reddish brown walls and which frequently contain an amorphous reddish brown substance; no or very few cork cells; calcium oxalate in raphides from 5 to  $8\mu$  in length.

**Constituents.**—*Volatile oil* (up to 1 per cent.) containing 55 to 65 per cent. of *cinnamic aldehyde*, 4 to 8 per cent. of *eugenol*; caryophyllene, *l*-phellan-

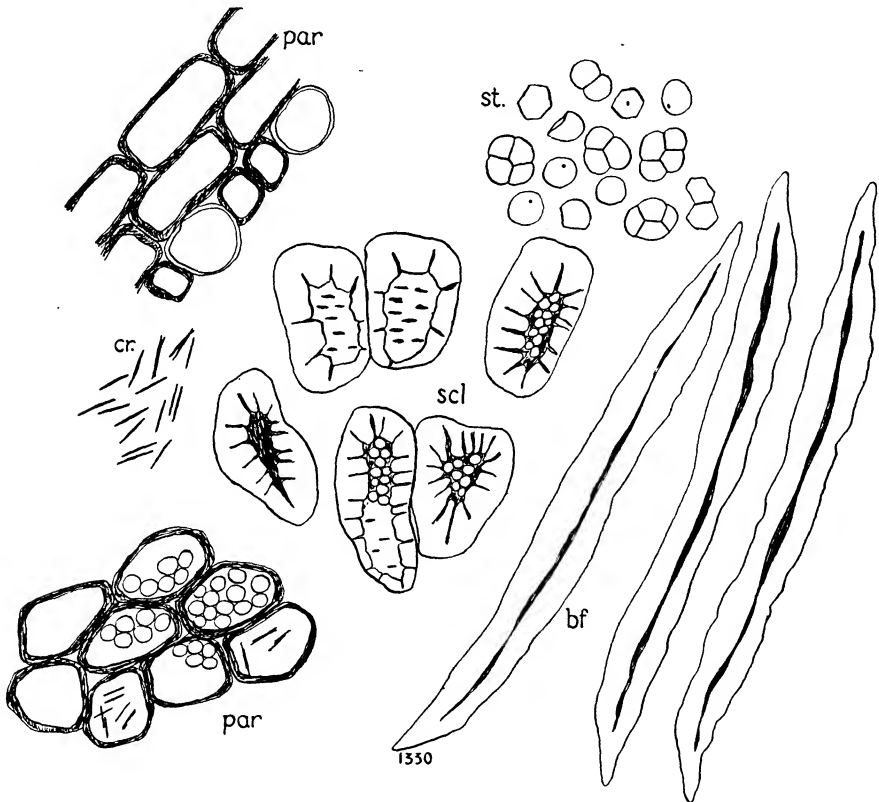


FIG. 182.—Powdered Ceylon Cinnamon. *par*, parenchyma, the upper fragment showing two spherical oil cells, the lower showing cells containing starch and short acicular crystals of calcium oxalate; *scl*, stone cells, the lumina of three of which contain starch grains; *cr*, acicular crystals of calcium oxalate; *st*, starch; *bf*, bast fibers. (Drawing by Miss J. Izzo.)

drene, p-cymene, benzaldehyde, pinene, methyl-n-amyl ketone, nonylic aldehyde, hydrocinnamic aldehyde, cuminic aldehyde, *l*-linalool, etc.; resin, mucilage, starch, tannin, calcium oxalate, etc.

**Uses.**—Aromatic, mild astringent and flavoring agent.

**Dose** (unof.).—0.25 Gm. (4 grains).

#### CASSIA CINNAMON (CINNAMOMUM CASSIA)

**Synonyms.**—Cassia Bark, Chinese Cassia, Cassia Ligneae, Canton Cassia; *Ger.* Chinesischer Zimmt; *Fr.* Casse.

**Botanical Origin.**—*Cinnamomum Cassia* (Nees) Nees ex Blume.

**Part Used.**—The dried bark.

**Ash.**—Not more than 5 per cent. of total ash, nor more than 2 per cent. of ash insoluble in hydrochloric acid. (U.S.D.A., S.R.A., F.D., Nov. 1936.)

**Habitat.**—Southeastern China, possibly Cochin China.

**Plant.**—An evergreen tree of medium height with oblong to sub-lanceolate, 3-nerved leaves and panicles of small yellow flowers.

**Production and Commerce.**—The trees are cultivated for the bark and oil of cassia in the provinces of Kwangsi and Kwangtung in southeastern China. The bark is collected from cultivated trees 5 to 7 years old which have been grown from seeds or cuttings planted in nursery beds, the seedlings of which were set out on hillsides when one or two years old and grown as a coppiced bush. The adventitious shoots are cut off when they attain a diameter of about  $\frac{1}{4}$  cm., then cut into segments, the bark loosened and stripped from the wood. The periderm is then scraped by means of a plane and the bark dried in the shade and sun. It is then made into bundles up to 40 cm. long and weighing from  $\frac{1}{2}$  K to 1 K. These are tied with split bamboo and packed into bamboo cases which are covered with bamboo mats. Very frequently the bundles contain chips and dirt in the center of long quills of bark on the outside. The commercial supplies come in boxes from China. The leaves, leaf stalks and twigs of this tree are gathered and distilled for *Oil of Cinnamon* U.S.P.

**Description.**—Cassia Cinnamon is similar in general microscopic appearance to Saigon Cinnamon but is usually partially scraped on the outer surface which is brownish with grayish areas where the cork is not removed. Its odor and taste are less aromatic and pungent. It possesses relatively more starch and relatively fewer bast fibers than the other cinnamon barks on the market. The bast fibers are up to  $40\mu$  in diameter. The individual starch grains are up to  $22\mu$  in diameter.

**Constituents.**—From 1 to 2 per cent. of *volatile oil* containing from 75 to 90 per cent. of *cinnamic aldehyde*; mucilage, resin, tannin, calcium oxalate, etc.

**Uses.**—Aromatic and flavoring agent.

**Dose.**—0.25 Gm. (4 grains); of volatile oil, 0.1 cc. ( $1\frac{1}{2}$  minims).

**Adulterant.**—The chief adulterant for both Saigon and Cassia Cinnamons is Java Cinnamon, more commonly known as Fagot- or Batavia-Cassia, the bark of *Cinnamomum Burmanii* Blume. This occurs mostly in double quills which are scraped, up to 3 mm. thick, reddish to light brown externally and possess a mucilaginous and less aromatic taste than the other cinnamons.

The powder forms a slimy mass with water and contains tabular and prismatic crystals in its medullary rays.

The table on page 373 is a summary of the chief differences between the imported commercial varieties of cinnamon barks.

**Cassia Buds** consist of the dried flowers of *Cinnamomum Cassia* and *C. Loureirii* (Fam. *Lauraceæ*) gathered shortly after opening. They are dark brown, club-, urn- or top-shaped, hard bodies, 5 to 10 mm. in diameter and consist of the rounded flower composed of a 6-parted perianth enclosing a

	Saigon	Ceylon	Cassia	Fagot
Quills	Single or double	Congeries, each with 7 to 12 pieces of bark	Single or double	Single or double (usually)
Outer surface	Unscraped	Cork and most of cortex removed	Partially scraped	Scraped
Taste	Pungently aromatic	Delicately and warmly aromatic	Mildly aromatic	Mucilaginous and mildly aromatic
Starch grains	Abundant and mostly over 10μ	Not abundant and usually under 10μ	Abundant, mostly over 10μ	Not abundant and usually under 10μ
Calcium oxalate in medullary-rays	Raphides	Raphides	Raphides	Tabular and prismatic crystals

1-celled ovary attached to a short pedicel. Their taste is strongly aromatic and cinnamon-like. The diagnostic elements occurring in the dark brown powder of cassia buds which distinguish it from a powdered cinnamon bark are as follows: Thick-walled, crooked, non-glandular hairs, spiral, reticulate and scalariform tracheæ, sclerenchyma fibers which are broad with blunt ends and large lumina, jointed sclerenchyma fibers with pointed ends, and characteristic stone cells of the ovary. Cassia buds are used as a spice.

#### CINNAMON OIL U.S.P. (OLEUM CINNAMOMI)

**Cinnamon Oil** or Oil of Cassia represents the volatile oil distilled with steam from the leaves and twigs of *Cinnamomum Cassia* (Nees) Nees ex Blume (Fam. *Lauraceæ*), rectified by distillation. It contains not less than 80 per cent by volume of the total aldehydes of oil of cinnamon. It occurs as a yellowish or brownish liquid possessing a cassia cinnamon odor and taste, darkening with age; sp. gr., 1.045 to 1.063 at 25°C.; opt. rot., not less than  $-1$  and not more than  $+1$  in a 100 mm. tube at 25°C.; ref. ind., 1.6020 to 1.6135 at 20°C.

Oil of Cassia contains as its chief constituent, *cinnamic aldehyde*,  $C_6H_5CH:CH.CHO$ . It is produced in the provinces of Kwangsi and Kwangtung in southeastern China. It is imported from Hong Kong in leaden containers. Stimulant and flavoring agent. Av. dose, 0.1 cc. ( $1\frac{1}{2}$  minims).

**Preparations.**—In U.S.P.: Cinnamon Water, Cinnamon Spirit, 1 cc. In N.F.: N.F. Dentifrice, Cinnamon Syrup, Cinnamon Tincture, Aromatic Castor Oil, Compound Vanillin Spirit.

**Oliver Bark** or **Black Sassafras** is the dried bark of *Cinnamomum Oliveri* Bailey, a tree indigenous to Queensland and New South Wales. It occurs in flat pieces about 1 cm. thick which are grayish-brown and warty on their outer surface, umber-brown and satiny on their inner surface. It yields a yellow, aromatic volatile oil containing safrol, pinene, cinnamic aldehyde, d-camphor and eugenol. It is used similarly to cinnamon.

**Clove Bark** or **Cortex Caryophyllatus** is the dried bark of *Dicypellium caryophyllatum* Nees (Fam. *Lauraceæ*), a tree native to Brazil. It occurs in dark



brown or purplish-brown, elongated, compound quills like Ceylon Cinnamon, the individual quills being scraped. It possesses a clove-like odor and aromatic, mucilaginous taste. Used as a spice.

CAMPHOR U.S.P. (CAMPHORA)

**Synonyms.**—Gum Camphor, Laurel Camphor; *Ger.* Kampher; *Fr.* Camphre.

**Botanical Origin.**—*Cinnamomum Camphora* (Linné) Nees et Ebermaier.

**Part Used.**—A ketone ( $C_{10}H_{16}O$ ) obtained from *Cinnamomum Camphora* (Natural Camphor); or produced synthetically (Synthetic Camphor).

**Habitat.**—China, Japan and Formosa.

**Plant.**—A large, much-branched evergreen tree, attaining a height of 60 to 100 feet and a trunk diameter of 20–45 inches; indigenous to Asia but naturalized in Mediterranean regions, Egypt, South Africa, Ceylon, Brazil, Jamaica and southern and southwestern United States. Its branches bear alternate, broadly lanceolate, entire, coriaceous leaves acuminate at both base and apex, shiny on upper surface and glaucous beneath. Its flowers are small and greenish-white to white. Its fruit is a purple, one-seeded drupe. The pedicels bearing the fruits end in a saucer-shaped disk.

**Production and Commerce.**—The camphor tree is cultivated on a large scale in Formosa and Japan for camphor, camphor oil and for its wood; which is used in cabinet work. It has been introduced into Southern and Southwestern United States, South America and Southern Europe for ornamental planting and into Mauritius, the Malay States, Florida, California, Texas and the Philippines for the production of camphor.

Camphor is found in crystalline form in the clefts of the roots and stems but most of it occurs dissolved in the volatile oil.

The bulk of the world's supply of this drug comes from Formosa and Japan. In these countries large natural forests of the camphor tree exist and production is under control of the Japanese government. A law of Japan requires a camphor tree planted for each one felled.

The methods employed in obtaining camphor vary in different districts. Those practised in the province of Tosa in Japan are reported by Dewey (Circular 12, U. S. Dep. of Agr., Div. of Botany) as follows: "The camphor trees are felled, and the trunk, larger limbs, and sometimes the roots are cut into chips by hand labor with a sharp concave adz. The fresh chips are placed in a wooden tub about 40 inches high and 20 inches in diameter at the base, tapering toward the top like an old-fashioned churn. The perforated bottom of the tub fits tightly over an iron pan of water on a furnace of masonry. The tub has a tight-fitting cover, which may be removed to put in the chips. It is surrounded by a layer of earth about 6 inches thick to aid in retaining a uniform temperature. A bamboo tube extends from near the top of the tub into the condenser. This consists of two wooden tubs of different sizes, the larger one right side up, kept about two-thirds full of water from a continuous stream which runs out of a hole in one side. The smaller one is inverted with its edges below the water, forming an air-tight chamber. This air chamber is kept cool by the water falling

on the top and running down over the sides. The upper part of the air chamber is sometimes filled with clean rice straw, on which the camphor crystallizes, while the oil drips down and collects on the surface of the water. In some cases the camphor gum and oil are allowed to collect together on the surface of the water, and are afterward separated by filtration through rice straw or by pressure.

"About 12 hours are required for distilling a tubful by this method. Then the chips are removed and dried for use in the furnace, and a new charge is put in. At the same time the camphor and oil are removed from the condenser. By this method 20 to 40 pounds of chips are required for 1 pound of crude camphor.

"The principles generally held to be essential in distilling camphor of good quality are: (1) The heat must be uniform and not too great, producing a steady supply of steam; (2) the steam, after liberating the camphor, must not come in contact with metal, that is, the tub and condensing apparatus must be of wood."

The *crude camphor* thus produced is of a dirty, pinkish-white color and in a mass of crystalline granules. In this condition it is frequently shipped to the United States and Europe where it is purified by mixing it with about one-fiftieth of its weight of quicklime, heating this mixture in an iron vessel to drive off the volatile oil and water and then heating the resultant residue in the iron vessel which is connected with a receiver. The vapors are condensed in the receiver as a sublimate in the form of crystals. This product is known as *Refined Camphor* or *Resublimed Camphor* and represents the kind of natural camphor which is official.

American Camphor has been produced in Florida by subliming the leaves and twigs of the camphor tree.

**Synthetic Camphor** is produced from pinene by a process wherein pinene is converted into pinene hydrochloride from which isoborneol is prepared. The isoborneol is then oxidized to form camphor.

In California, *Ramona stachyoides*, *Artemisia trifolium* and *Artemisia frigida* are grown for Camphor. The volatile oil of the first of these contains about 40 per cent. of camphor. Camphor has recently been found in the volatile oil of the Camphor Basil, *Ocimum kilimandscharicum* Gürke. Camphor is imported into this country in tin-lined or zinc-lined cases. Crude camphor comes to the United States from Hong-Kong and Foochow, China, and from Formosa; refined camphor from Shanghai, China, and from Japan and Formosa. Synthetic camphor is produced on a large scale at Deepwater, N. J.

**Description.**—Camphor occurs as colorless crystals, granules, or crystalline masses, or as colorless to white, translucent, tough masses; fracture uneven, the fractured surface being irregular and transparent; odor penetrating and characteristic; taste pungent and aromatic. Its specific gravity is about 0.990 at 25°C. It is freely soluble in alcohol, chloroform, ether, carbon disulphide, benzin, or in fixed and volatile oils, but only slightly soluble in water. When triturated with equal parts of either menthol, thymol, chloral hydrate, salol, phenol, naphthol or resorcin, it forms a liquid. It is readily pulverizable in the presence of a



FIG. 183.—Leafy and fruiting branches of the camphor tree (*Cinnamomum Camphora*).  
(Photograph by Stuhr, from Christensen.)

little alcohol. It melts between  $175^{\circ}$  and  $179^{\circ}\text{C.}$  and volatilizes at ordinary temperatures. Natural Camphor is dextrorotatory.

**Powdered Drug.**—White. When a drop of 1:100 solution of vanillin and a drop of concentrated sulfuric acid are added to powdered camphor on a glass slide over a white surface, a succession of colors, passing through yellow, red, violet and blue, is evident.

**Constituents.**—Chiefly a saturated ketone, having a chemical formula of  $\text{C}_{10}\text{H}_{16}\text{O}$ .

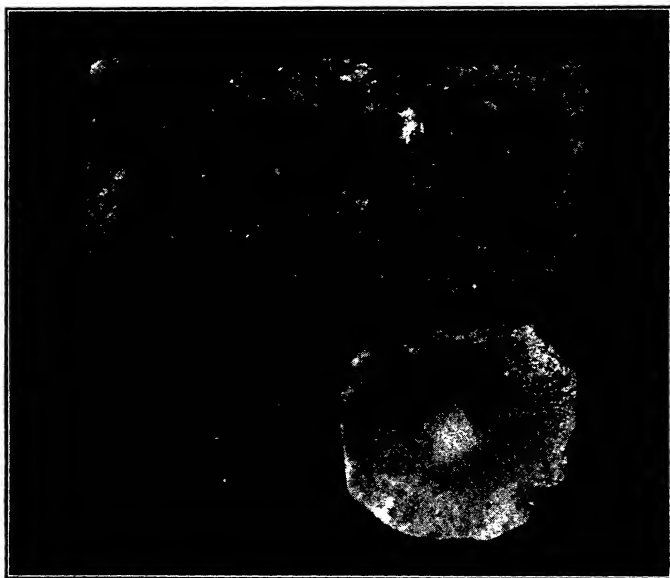


FIG. 184.—Camphor,  $\times \frac{1}{2}$ .

**Uses.**—Camphor is employed externally in the form of spirit or liniment as a rubefacient; internally as an antiseptic and carminative and hypodermically, in the form of a sterile solution in oil, as a cardiac stimulant. Large quantities are used in the manufacture of celluloid and pyroxylin plastics.

**Average Dose.**—Oral or intramuscular, 200 mg. (3 grains).

**Preparations.**—In U.S.P.—Camphor Water, Camphor Liniment, Camphor and Soap Liniment, Chloroform Liniment (from Camphor and Soap Liniment), Camphorated Opium Tincture (*Paregoric*). In N.F.—Camphor Ampuls, 0.2 Gm. of camphor; Monobromated Camphor, 0.125 Gm. (2 gr.); Camphor Spirit, 1 cc. (15 m.); Camphor Ointment, Camphorated Phenol, Solid Soap Liniment (Solid Opodeldoc), Compound Menthol Spray, Compound Ephedrine Spray, Lead Subacetate Cerate.

**Substitutes.**—**Borneo Camphor** is a camphor naturally deposited in the clefts and hollows of the wood of *Dryobalanops aromatica* Gaertner, a tree belonging to the *Dipterocarpaceae* family and growing in Borneo and Sumatra. This product is almost entirely consumed in China and the East Indies. It consists

mostly of dextro-borneol, a substance which can be transformed to true camphor by treatment with nitric acid.

**Blumea or Ngai Camphor** is a product resembling true camphor obtained by distillation from *Blumea balsamifera*, a shrub of the Malay Peninsula and Burma.

**Adulterants.**—Stearic acid has occasionally been added to camphor. Ammonium chloride has been reported in a sample of camphor imported from Formosa.

#### LAURUS (BAY LAUREL)

**Synonyms.**—Bay Laurel Leaves, Grecian Laurel Leaves, Bay Leaves; *Ger.* Lorbeerblätter; *Fr.* Feuilles de laurier.

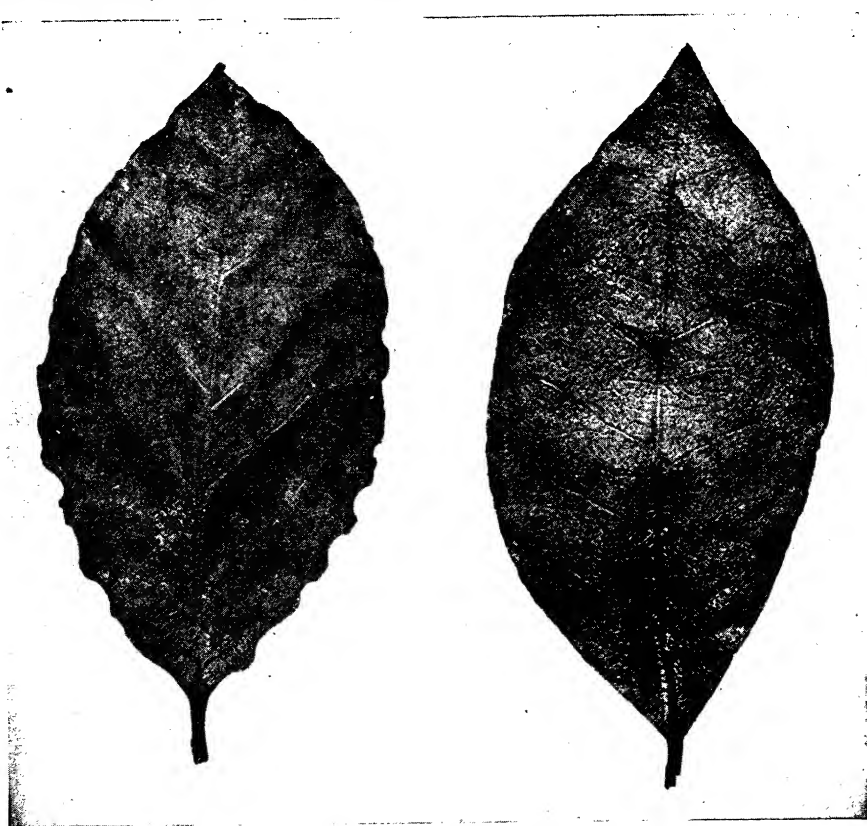


FIG. 185.—Bay Leaves (*Laurus nobilis* L.). nat. size.

**Botanical Origin.**—*Laurus nobilis* Linné.

**Part Used.**—The dried leaf.

**Habitat.**—Mediterranean region.

**Plant.**—A tree with simple, alternate, lanceolate to ovate leaves, yellow flowers and purple drupe fruits. The leafy and fruiting twigs of it were used by the ancient Greeks in wreaths to crown their heroes and poets.

**Description.**—Bay Laurel leaf occurs as entire and broken leaves some of which are attached to twigs; when entire, leaf-blades lanceolate, ovate-lanceolate or ovate, stiff and coriaceous, with petiole up to about 10 mm. in length; apex of lamina acute, base acute, margin revolute; upper surface glabrous and shiny, olive green to brown; lower surface dull olive to brown with a prominent midrib and veins of the first order; characteristically fragrant upon crushing; taste aromatic and characteristic.

**Histology.**—Sections of the *leaf-blade* possess an upper and lower epidermis with a thick cuticle and thick, porous walls, the cells of the lower epidermis with walls more curvilinear and distinctly beaded, as viewed in surface section. The lower epidermis alone shows stomata which are arranged singly and in pairs. The mesophyll is differentiated into an upper region of two layers of palisade parenchyma and a lower region of spongy parenchyma in which are scattered spheroidal oil-reservoirs. Through the mesophyll course numerous fibrovascular bundles with spiral, reticulate and pitted tracheæ, the bundles in the stronger veins being supported above and below by thick-walled fibers which extend to both epidermises. Surface sections of the *petiole* exhibit an epidermis with somewhat wavy-walled cells and unicellular curved hairs with dark contents.

**Constituents.**—*Volatile oil* (2.5 to 3.6 per cent.) containing *cineol* (about 50 per cent.), *l-linalool*, *geraniol*, *terpineol*, *eugenol*, valeric and caproic acids, etc.; fixed oil, protein, pentosans, etc.

**Uses.**—As spice and flavoring agent for meats, poultry, meat sauces and pickles.

#### PAPAVERACEÆ (POPPY FAMILY)

Herbs with milky or colored juices present in either laticiferous vessels (*Papaver*) or in laticiferous cells which are sac- or tube-like (*Chelidonium*). The flowers are regular with their parts in twos or fours. The fruit is a capsule containing numerous oily albuminous seeds. Calcium oxalate is wanting, except in *Bocconia frutescens*, where it is found in clustered crystals. Glandular trichomes are absent and uniseriate non-glandular trichomes are only present in some of the genera. Stomata occur either on both surfaces of the leaves or on the lower surface only. The guard cells of these are surrounded by ordinary epidermal cells. In several species of *Papaver*, including *Papaver somniferum*, groups of water stomata are present in depressions on the lower surface of the leaf teeth.

#### OPIUM U.S.P. (OPIUM)

**Synonyms.**—Succus Thebaicus, *Gum Opium*, Thebaicum, Meconium; *Ger.* Mohnsaft; *Fr.* Pavot officinal, Opium.

**Botanical Origin.**—*Papaver somniferum* L. and its variety *album* DeCandolle.

**Part Used.**—The air-dried milky exudation (latex) obtained by incising the unripe capsules.

**Standard of Assay.**—It yields not less than 9.5 per cent. of anhydrous morphine.

**Habitat.**—Asia. Cultivated.

**Plants.**—Annual herbs with thick, branching, yellow root systems, the tap root of which gives rise to a smooth, glaucous, branched stem bearing alternate, dull green, ovate, clasping leaves that are irregularly cleft or toothed. The flowers are large and showy, solitary, varying in color from light pink to purplish-pink and purple (*P. somniferum*) to silvery white (*P. somniferum* var. *album*), and nodding in the bud stage. Each flower consists of a receptacle

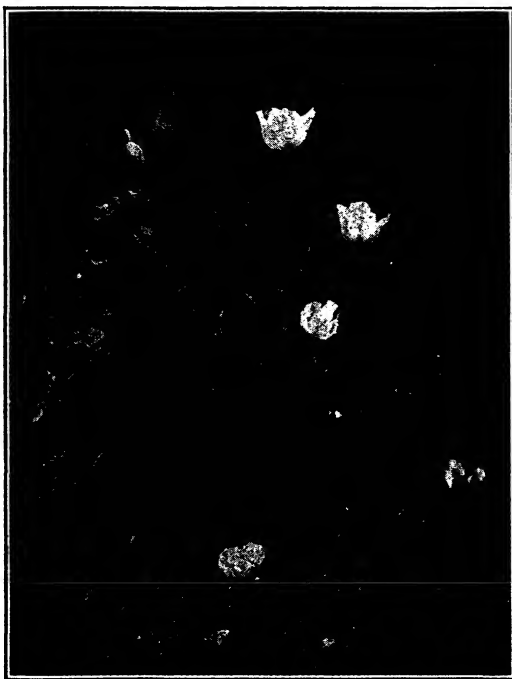


FIG. 186.—*Papaver somniferum* var. *album*, a source of Opium.

borne on the end of a long peduncle and bearing 2 green sepals, 4 colored petals, numerous stamens and an incompletely many-celled ovary bearing on its summit a radiate stigma. The fruit is a capsule, dehiscing by terminal pores beneath the stigma and containing numerous small, reniform, bluish, cream colored or white seeds, each with an oily endosperm. The bluish seeds obtained from ripe capsules of the variety *nigrum* DC. are known in commerce as “*maw seeds*.”

**Production and Commerce.**—Opium is obtained from plants that have been cultivated in rich, well-manured soil in warm and temperate climes. The poppy seed, often mixed with sand, is sown broadcast over the tilled field in early autumn. About 13 ounces of seed is used in Asia Minor to the acre. The fields are weeded in the spring when the poppy has attained a height of

about 6 inches and the plants thinned to stand about 2 feet apart. The plants flower in April and May and the capsules mature from June to July. While nearly all parts of the poppy contain a white milk juice or latex, the unripe capsules contain it in especial abundance. The capsular wall is traversed by a network of branching and anastomosing laticiferous vessels which contain the



FIG. 187.—Original chest of opium, as imported from Turkey. (*Courtesy of Parke, Davis and Company.*)

latex. In the green, unripe condition this latex is richest in morphine content, but as the capsules turn yellow and ripen, the morphine content diminishes while that of codeine and narcotine increases.

The drug is collected chiefly in Turkey, Macedonia, Bulgaria, Asia Minor, Persia, Yugoslavia, India and China. The method of collecting it is, in general, as follows: Shortly after the petals and stamens fall, generally in the late



afternoon or early morning while the temperature is low, transverse, oblique or vertical incisions are made into the unripe capsules by means of a single-bladed knife with one saw edge (dgeezguee) or a several bladed knife (nushtur), care being observed not to cut through the inner wall of the capsule lest valuable juice be lost and the seeds injured. The white latex exudes and soon hardens on the outer surface of the capsule into brownish masses which are scraped off the following day on a wooden tray. The scrapings are later transferred to earthen vessels or larger trays or dumped on the ground, where the opium is kneaded by the hands to a uniform consistency. It is then shaped into balls, cakes or rarely sticks.

In Turkey, Asia Minor, Bulgaria and Macedonia the opium is generally made into compressed spheroidal or flattened cakes of varying size and usually weighing from 100 grams to several kilograms. These are covered with poppy leaves and dried for several days in the shade or sun. When sufficiently dry they are packed in wicker baskets or cotton bags with the reddish-brown winged fruits of a *Rumex* species to prevent them from cohering. In Persia, after collection, the drug is kneaded, frequently with gum, into a uniform mass and then usually cut into brick-shaped masses which are dried and wrapped in red or white paper and tied with red or yellow string. In India the masses may be partially dried in the sun and made into round balls (*Malwa opium*) or flat cakes (*Bengal abkari opium*) and wrapped in oiled paper. At Ghazipur, India, three kinds of opium are produced, viz: *Excise Opium*, of 90° consistency, which is made into cubical cakes weighing about 2 pounds and which is consumed in India; *Provision Opium*, of about 70° consistency, which is worked into spheroidal masses or cakes, each weighing about 3½ pounds and employed in alkaloid manufacture; *Medical Opium*, of about 88° consistency, which occurs in square blocks or in flat cakes each weighing 2 pounds and wrapped in wax paper.

The commercial varieties of opium are as follows: 1. Turkey, Smyrna, or Constantinople; 2. Persian; 3. Chinese; 4. Indian. The drug chiefly comes from Turkey and Persia in tin- or zinc-lined wooden cases.

During 1947, 431,789 pounds of opium were imported into this country from Turkey, Iran and Yugoslavia.

**Turkey Opium** is generally recognized as the best grade and is the kind seen most commonly on the American and English markets. It is produced in various parts of Turkey, Asia Minor, Bulgaria, Yugoslavia and Macedonia. Constantinople, Smyrna and Salonica are the chief opium centers. There are several sub-varieties of this named either after the districts in which the drug is produced or the shipping point. The most important of these are the Salonica, Malatia, Tokat, Karahissar, Ghiveh, Balukissar and Boghaditz opiums. The Malatia opium comes in loaves weighing 4 to 5 oz. and is of low morphine content.

The term "Druggists Opium" is applied to those sub-varieties of Turkey Opium which are relatively low in moisture content (10 to 25 per cent.) and which are employed in the preparation of granular and powdered opium U.S.P.

"Soft Shipping Opium" is comparatively fresh soft Turkey or Balkan Opium which averagely contains 30 per cent. or more of moisture. That produced in Macedonia and Yugoslavia is most esteemed by morphine manufacturers in the U.S. because of its averagely high morphine content.

"Turkish Government Monopoly Opium" is prepared by taking a considerable weight of opium gathered by a number of collectors, passing it through a mill and then forming it into cheese-shaped masses of uniform weight (4 lb., 6 oz.) which are covered with powdered poppy leaves. Each mass bears a black and gold label carrying a star and crescent and the letters IMU. The anhydrous morphine content of these masses is fairly constant, being about 13 per cent.

All of these are covered with remnants of poppy leaves and packed with Rumex fruits. The drug is exported from Istanbul and Smyrna. It yields 10 to 21 per cent. of morphine.

**Persian Opium** occurs in brick-shaped masses wrapped in red, glossy paper, rarely, in short cylindrical sticks or flat masses, in short truncate cones wrapped in red or white paper, or in flat circular cakes. It is usually of a dark brown color internally, non-granular and homogeneous. It yields 0.38 to 13.5 per cent. of morphine (usually 4-12 per cent.). This variety contains considerable starch.

**Indian Opium** is produced at Ghazipur, India. It occurs either in spheroidal masses covered on the surface with dried petals and leaves that have been agglutinated with washings and extract of juice and then dried, or in square or brick-shaped masses weighing about 2 pounds and covered with an oiled paper wrapper. It is either dark-brown or black in color, of homogeneous, pasty, texture and possesses a very bitter taste. It yields from 3 to 15 per cent of morphine (usually 7.5 to 10 per cent.).

**Chinese Opium** occurs in flat globular cakes frequently wrapped in white paper. Used entirely by the Chinese. It contains from 4.3 to 11.2 per cent. of morphine.

While the capsules of the Poppy are green they contain the greatest percentage of morphine, but during the ripening process, the amount of this alkaloid decreases while the percentage of other alkaloids like narcotine and codeine increases.

**Description.**—In rounded or flattened masses of variable size and outline usually about 8 to 15 cm. in diameter and weighing from 4 ounces to 2 pounds; externally grayish-brown, brown or black, covered with fragments of poppy or rumex leaves and at times with some Rumex fruits which adhere from the packing; plastic (tearing apart), when fresh, but becoming hard and brittle through prolonged keeping; internally coarsely granular or nearly smooth, dark brown, sometimes interspersed with lighter areas; odor peculiar, narcotic: taste very bitter, characteristic.

**Powdered Opium (Opium Pulveratum) U.S.P.**—Light brown to moderate yellowish brown. The characteristic histological elements are yellowish-brown to brownish-red, irregular, granular fragments of hardened latex; fragments of

epidermis of poppy capsule consisting of polygonal or narrowly elongated cells with lignified walls; fragments of epidermal cells of poppy or rumex leaves with elliptical stomata, fragments of rumex fruits with fibrovascular tissue and little or no starch. In addition to these, powdered opium may contain crystals of sugar of milk and fragments of Cacao shells which are used as diluents in order to bring powdered opium of high alkaloidal yield down to the official standard (not less than 10 per cent. nor more than 10.5 per cent. of anhydrous morphine).

**Granulated Opium (Opium Granulatum) U.S.P.** is opium, dried at a temperature not exceeding 70°C., and reduced to granules, all of which will pass through a No. 16 standard mesh sieve and not more than 10 per cent through a No. 60 standard mesh sieve. It yields not less than 10 per cent and not more than 10.5 per cent of anhydrous morphine.

**Constituents.**—Alkaloids (*morphine*, *codeine*, *narcotine*, *narceine*, *papaverine*, thebaine, protopine, laudanine, codamine, cryptopine, gnoscopine, lanthopine, laudanidine, deuteropine, meconine, meconidine, pseudomorphine, etc.), in combination with meconic or sulfuric acid; free meconic acid, glucose, mucilage, pectin, wax, fatty matter, caoutchouc, meconin, odoriferous substances and coloring matter.

*Morphine* ( $C_{17}H_{19}O_3N.H_2O$ ), the principal alkaloid, belongs to phenanthrene group of opium alkaloids. It crystallizes from alcoholic solutions in orthorhombic prisms and needles from 100 $\mu$  to 800 $\mu$  in length. Its sulfate occurs as white, feathery, silky crystals or cubical masses of crystals or as a white, crystalline powder which crystallizes from aqueous solutions in orthorhombic prisms and needles. Sulfuric acid containing in each cc. one drop of formaldehyde T.S. colors it a brilliant purple while nitric acid colors it orange-red, fading to yellow. If potassium ferricyanide T.S., containing 1 drop of ferric chloride test solution in each cc., is added to an aqueous solution of morphine sulfate (1:100), a deep blue color is produced (difference from codeine).

*Codeine* ( $C_{18}H_{21}O_3N.H_2O$ ) or methyl-morphine, another member of the phenanthrene group of opium alkaloids, occurs as colorless crystals, or as a white crystalline powder. Its sulfate crystallizes from hot alcoholic solutions in the form of orthorhombic prisms up to 2.5 mm. in length. Sulfuric acid containing 0.005 Gm. of selenous acid in each cc. produces with codeine or its sulfate or phosphate a green color, which changes rapidly to blue, then slowly back to green.

*Papaverine* ( $C_{20}H_{21}O_4N$ ), a member of the benzyl-isoquinoline group of opium alkaloids, occurs as colorless needles and prisms which are colored purple to violet by warming in sulfuric acid. It may be distinguished from other opium alkaloids by the following test: Dissolve about 1 mg. of Papaverine hydrochloride in 10 cc. of distilled water, add 3 drops of diluted hydrochloric acid and 5 drops of potassium ferricyanide T. S., when a lemon-yellow precipitate of papaverine ferricyanide forms at once.

**Uses.**—Opium and morphine are used as somnifacient, analgesic, and cal-  
mative agents. Morphine and Dihydromorphinone hydrochloride have become dependable drugs for the alleviation of pain. Codeine is employed

as a sedative in coughs and for the relief of acute colds. Papaverine is employed to relax spasm of smooth muscle such as vascular spasm associated with peripheral arterial embolism and thrombosis, angina pectoris, urethral colic, biliary colic, bronchial spasm, gastrointestinal spasm and dysmenorrhea. Dover's Powder (*Pulvis Ipecacuanhæ et Opii*) and Tully's Powder (*Pulvis Morphinæ Compositus*) have a diaphoretic action.

**Average Dose** of Opium, Granulated Opium and Powdered Opium, 60 mg. (1 gr.); of Morphine sulfate U.S.P., 10 mg. ( $\frac{1}{6}$  gr.); Morphine hydrochloride

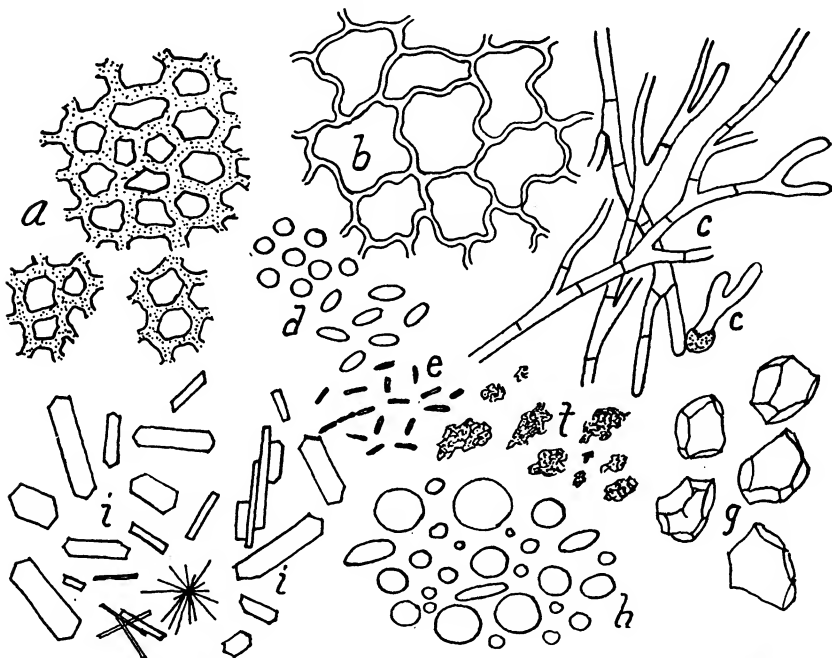


FIG. 188.—Powdered Opium. (a) Epidermal fragments of the pericarp are very abundantly present in Turkish opium; (b) epidermal cells of the poppy leaf which are likewise abundantly present in gum opium; (c) mold hyphæ are usually abundant as are also mold spores (d); (e) bacteria are abundant; (f) dirt particles and (g) sand particles are present; (h) cereal (wheat) starch is usually present in small amounts; (i) crystals of the meconates which are especially abundant in Persian gum opium and constitute the characteristic inclusions of the Chinese smoking opium. It is possible to determine the alkaloidal strength of the Chinese smoking opium by the numerical crystal count. (Schneider.)

(N.F.), 8 mg. ( $\frac{1}{8}$  gr.); of Codeine N.F., Codeine sulfate and Codeine phosphate U.S.P., 30 mg. ( $\frac{1}{2}$  grain); of Cotarnine chloride N.F., 60 mg. (1 grain); of Papaverine hydrochloride, U.S.P., Oral and intravenous, 0.1 Gm. (1½ gr.); of Dihydromorphininone hydrochloride U.S.P., (Dilaudid HCl) 2 mg. ( $\frac{1}{30}$  grain); of Apomorphine HCl U.S.P., Emetic, subcutaneous, 5 mg. ( $\frac{1}{12}$  grain).

**Preparations.**—In U.S.P., *Opium Granulatum*, 60 mg. (1 gr.); *Tinctura Opii* or *Laudanum* (from *Gran. Opium*) 0.6 cc. (10 minims); *Tinctura Opii Camphorata* or *Paregoric* (from *Tr. or P. Opii*) 4 cc.; *Opium Pulveratum*, 60 mg. In N.F., *Extractum Opii*, 30 mg. ( $\frac{1}{2}$  gr.); *Mistura Carminativa*, for infants, 0.5 cc. (8 minims); *Mistura Pectoralis*, 4 cc.; *Mistura Opii et Glycyrrhizæ Composita*,

4 cc. (1 fl. dr.); Pulvis Ipecacuanhæ et Opii (from P. Opium), 0.3 Gm. (5 grains); Tinctura Ipecacuanhæ et Opii, 0.5 cc.; Lotio Plumbi et Opii.

**Preparations of Alkaloids (in U.S.P.):** Tabellæ Codeinæ Phosphatis, 30 mg. ( $\frac{1}{2}$  gr.), Tabellæ Codeinæ Sulfatis, 30 mg. ( $\frac{1}{2}$  gr.); Tabellæ Dihydromorphinoni Hydrochloridi, 2 mg. ( $\frac{1}{30}$  gr.); Tabellæ Morphinæ Sulfatis, 10 mg. ( $\frac{1}{6}$  gr.). Injectio Morphinæ, 10 mg. ( $\frac{1}{6}$  gr.) of the morphine salt; Injectio Papaverinæ Hydrochloridi, Intravenous, 0.1 Gm. ( $1\frac{1}{2}$  gr.).

**Preparations of Alkaloids (in N.F.):** Tabellæ Morphinæ et Atropinæ Sulfatum (Morph. Sulf. 15 mg. ( $\frac{1}{4}$  grain) and 0.4 mg. ( $\frac{1}{150}$  grain) of Atrop. Sulf.); Elixir Terpini Hydratis et Codeinæ, 4 cc.; Syrupus Pinæ Albæ Compositus cum Codeina, 4 cc. (1 fl. dr.). Pantopon (Pantopium Hydrochloride) is a mixture of the hydrochlorides of the alkaloids of opium in the proportion in which they exist in Smyrna opium, and containing 50 per cent. of anhydrous morphine. Dose,  $\frac{1}{12}$  to  $\frac{1}{3}$  gr.

• **Substitutes.**—Several factitious samples of Opium have appeared on the market of blackish-brown color, all deficient in odor and taste and probably representing aqueous extracts of the poppy plant.

**Adulterants.**—Lead bullets, clay, sand, pebbles, starch, gums, aqueous extract of herbs, pulp of figs, molasses, exhausted opium, extract of poppy capsules, ashes, lead piping, powdered cumin fruits, etc.

**Cotarninæ Chloridum N.F.** (Cotarnine Chloride) is the chloride of an alkaloid obtained by the oxidation of narcotine. It occurs in the form of a yellow, odorless powder. 1 Gm. is soluble in about 1 cc. of water and about 4 cc. of alcohol.

**Uses.**—In menorrhagia and metrorrhagia to check bleeding of the uterus. Av. dose, 60 mg. (1 grain).

**Amidon Hydrochloride**, also known as Dolophine (Lilly), Methadon (Abbott) and Adanon (Winthrop), is a new analgesic, representing a synthetic substitute for morphine. It occurs as a white, crystalline powder having a bitter taste; 12 Gm. soluble in 100 cc. of water. **Dosage.**—Oral, 2.5 to 5 mg.; Subcutaneous, 10 mg.; Intravenous, for excruciating pain, 20 mg.

#### PAPAVERIS FRUCTUS (POPPY CAPSULES)

**Synonyms.**—Poppy Fruits, *Ger.* Mohnkapseln; *Fr.* Capsules de Pavot blanc ou Pavot officinal.

**Botanical Origin.**—*Papaver somniferum* L.

**Part Used.**—The dried, fully grown, unripe fruit, to be freed of seeds before making pharmaceutical preparations.

**Description.**—In globular or oval capsules of variable size, constricted at the base and frequently joined with a short, yellow stalk; crowned at the summit with a 7- to 15-rayed, disk-shaped stigma; outer surface of pericarp smooth, longitudinally furrowed, grayish- to brownish-yellow, often marked with black spots; interior surface bearing thin, brittle placentæ which extend from the sutures for a short distance toward the center and bear numerous tiny, reticulated, reniform, white seeds; odor indistinct; taste bitter.

**Constituents.**—About 0.2 per cent. of *morphine*, and minute traces of other alkaloids and meconic acid.

**Uses.**—Poppy capsules, deprived of their seeds, have been used in the preparation of a sedative syrup. The seeds which abound in a fixed oil are used as a food as well as a source of Poppy oil. Poppy oil is employed by artists as a drying oil and is also used as a salad dressing.

**Average Dose.**—1 Gm. (15 grains).

#### SANGUINARIA N.F. (SANGUINARIA)

**Synonyms.**—*Bloodroot*, Red Puccoon, Indian Red Paint, Tetterwort, Red Root; *Ger.* Blutwurz; *Fr.* Sanguinaire.

**Botanical Origin.**—*Sanguinaria canadensis* L.

**Parts Used.**—The dried rhizome.

**Purity Rubric.**—Not more than 5 per cent. of the roots of the plant and not more than 2 per cent. of other foreign organic matter. It yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—In rich open woods of North America.

**Plant.**—A low perennial herb, the underground portion of which consists of a horizontally growing, branched rhizome bearing slender rootlets. Both rhizome and rootlets, when freshly broken, emit a red-orange acrid latex. In early spring the rhizome sends up a reniform, palmately 7-9-lobed leaf, with reddish veins, and a scape bearing on its end a large white flower. The flower shows 2 fugacious green sepals, 8-12 white petals, 24 stamens and a fleshy pistil bearing a 2-grooved stigma. The fruit is a 2-valved, 1-celled, many-seeded capsule.

**Collection.**—The rhizome and roots should be collected in early summer and carefully dried. Rhizomes which are shrivelled, gray internally and devoid of starch should be rejected. The commercial supplies come chiefly from the Southern Appalachian district.

**Description.**—The drug occurs in entire and broken pieces of rhizome and roots. Rhizome, of horizontal growth, more or less cylindrical, somewhat vertically compressed, simple or branched, 2 to 7 cm. in length and 5-16 mm. in diameter; externally brown, slightly annulate from leaf scars, showing on its upper surface a few stem scars and, on its lower and lateral surfaces, numerous intact or broken filiform roots and also root-scars; fracture short and uneven exhibiting a waxy, dusky red to moderate orange interior with yellowish fibrovascular bundles; odor indistinct; taste acrid and bitter.

**Histology.**—Transverse sections, when examined microscopically, show the following structures:

1. *Epidermis*, a layer of thin-walled, outer cells.
2. *Cortex* consisting of about 10 to 15 rows of parenchyma cells with thin walls, and containing numerous small spheroidal, ovoid, or plano-convex starch grains, and occasionally globules of fixed oil.
3. A comparatively narrow circular zone of numerous small, open collateral, *fibrovascular bundles* separated from each other by short medullary-rays.

4. A very broad *pith* of thin-walled parenchyma cells rich in starch.
5. *Latex cells*, either isolated or arranged in chains and containing an orange-red, red or reddish-brown latex, are to be observed scattered among the cells of the cortex, pith and medullary-rays.



FIG. 189.—A group of Bloodroot plants (*Sanguinaria canadensis*) growing in woodland during spring. The leaves, incompletely expanded, are wrapped around the flower stalks.

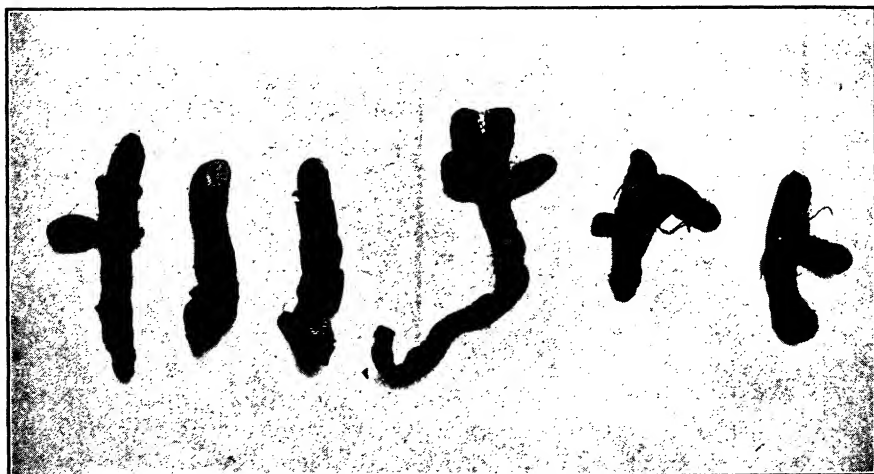


FIG. 190.—*Sanguinaria*  $\times 14$ . (Photograph by Stoneback.)

**Powdered Drug.**—Light brown to dark orange; sternutatory; showing numerous fragments of parenchyma bearing short latex cells with reddish-orange to orange resinous masses; numerous starch grains, mostly single, occasionally 2- to 3-compound, the individual grains spheroidal, ovoid or plano-

convex, polarizing light, and up to  $20\mu$  in diameter; few fragments of tracheæ with slit-like pores.

**Constituents.**—The alkaloids *sanguinarine* (about 1 per cent.), chelerythrine, protopine,  $\beta$ - and  $\gamma$ -homochelidonine; resin, citric and malic acids, and starch. Sanguinarine, the chief active ingredient, crystallizes in colorless needles and forms reddish salts with sulfuric and nitric acids.

**Uses.**—Blood Root is used as a stimulating expectorant and an emetic.

**Average Dose.**—0.125 Gm. (2 grains); of sanguinarine nitrate,  $\frac{1}{12}$  grain.

**Preparations.**—Compound White Pine Syrup (*Syrupus Pini Albæ Compositus*) 4 cc. (1 fl. dr.); Compound White Pine Syrup with Codeine (from Comp. W.P. Syr.), 4 cc. (1 fl. dr.).

#### FUMARIACEÆ (FUMITORY FAMILY)

Delicate herbs, rarely shrubs, with milky-watery to watery latex containing alkaloids. Leaves more or less compound. Inflorescence a raceme or spike. Flowers irregular, zygomorphic, one or both of the petals of which have a spur. Fruit a one-chambered capsule. Seeds albuminous. Idioblasts common.

#### CORYDALIS (CORYDALIS)

**Synonyms.**—(1) Turkey Corn, Squirrel Corn; (2) Dutchman's Breeches.

**Botanical Origin.**—(1) *Dicentra canadensis* (Goldie) Walpers [*Bicuculla canadensis* (Goldie) Millspaugh], and (2) *Dicentra Cucullaria* (Linné) Bernh. [*Bicuculla Cucullaria* (Linné) Millspaugh].

**Parts Used.**—The dried tubers of *D. canadensis* or of *D. Cucullaria*.

**Habitat.**—(1) Nova Scotia to Minnesota, south to Kentucky and Missouri. (2) Nova Scotia to Minnesota, south to North Carolina and Missouri.

**Plants.**—*Dicentra canadensis* (Goldie) Walpers is a smooth, delicate herb of rich woodlands whose underground portion consists of branched slender rhizomes bearing rootlets and scattered pea-like tubers of yellowish or reddish aspect. Its aerial portion consists of narrow petioled, ternately-compound, glaucous, dissected leaves with linear lobes, and a delicate raceme of heart-shaped flowers having a fragrance resembling hyacinths. The corolla is closed, heart-shaped, flattened and 2-spurred, the spurs being short and rounded. The color is greenish-white, tipped with pink. The fruit is a several-seeded pod.

*Dicentra Cucullaria* (L.) Bernh. somewhat resembles the former species in habit but differs mainly from it in bearing an underground vertical rhizome and tuberous bases of leaves, each cluster unit resembling a scaly bulb, by the flowers being white, tipped with creamy yellow, and in having the spurs of the corolla much longer.

**Description.**—Tubers of *Dicentra canadensis* spheroidal and often vertically depressed, one surface more or less concave, up to 15 mm. in diameter and 8 mm. in height, usually single, rarely 2 or more in a cluster; externally minutely pitted or nearly smooth; dusky reddish-brown to weak yellowish-orange and more or less translucent; the lower surface concave with a triangular scar from detached roots, upper surface usually with the remains of a slender rhizome;



fracture hard and horny or somewhat tough and granular; broken or cut surface showing a moderate brown to weak yellow, sometimes waxy interior; odor indistinct; taste slightly bitter.

"Bulbs" of *D. Cucullaria* consisting of the erect rhizome and the thickened tuberous bases of the leaves, the larger ones usually uppermost; leaf bases often falling away when dry, 20 or more to a bulb, ovoid or triangular-ovoid, the larger ones obtuse, up to 12 mm. in length, concave on the inner surface, the smaller ones acute; scarred at the apex where the petiole has fallen away and at the base where it has become detached from the rhizome; 3 or 4 leaf bases usually attached to some of the short rhizomes; external and internal color resembling the tuber of *Dicentra canadensis* but generally lighter; texture hard and horny; odor indistinct; taste slightly bitter.

**Constituents.**—The alkaloids *corydaline* and *bulbocapnine*, *protopine*, *cryptopine*, *corydine*, *isocorydine* and *bicuculline*, fumaric acid, a yellow *bitter principle*, resin, starch, etc.

**Uses.**—Corydalis has been employed as a bitter tonic, "alterative" and diuretic. Bulbocapnine is used in Ménières disease, muscular tremors, etc., and by veterinarians as a preanesthetic.

**Average Dose.**—0.6 Gm. (10 grains); of bulbocapnine, 1½ to 3 grains.

#### CRUCIFERÆ (MUSTARD FAMILY)

A family of herbs, rarely shrubs, growing for the most part in temperate regions. The leaves are alternate, simple, rarely compound, exstipulate, entire or toothed, often more or less hairy. The inflorescence at first is a corymb or shortened raceme, later elongating into a loose raceme. The flowers are regular—rarely irregular (Candytuft), and tetramerous; sepals 4, green, equal, or the 2 laterals may be pouched as nectar receptacles; petals 4, yellow to white, pink or purple and arranged in the form of a cross; stamens tetradynamous, hypogynous; pistil, syncarpous, bicarpellate, superior; carpels lateral; ovary 1-celled but falsely 2-celled by a placental replum and containing several ovules attached to a marginal placenta. The fruit is a capsule (silique) that bursts lengthwise by two valves. The seeds are exalbuminous.

Clear secretory cells containing myrosin are widely distributed and found in all the organs. The stomatal apparatus is characteristic; the pair of guard cells is surrounded by three neighboring cells, one of which is smaller than the other two. The medullary-rays in the xylem are usually prosenchymatous. Crystals of calcium oxalate are wanting. The unicellular non-glandular hairs are found in a variety of shapes. Glandular hairs have been found in comparatively few genera.

#### WHITE MUSTARD (SINAPIS ALBA)

**Synonyms.**—Yellow Mustard; *Ger.* Weisser Senfsamen; *Fr.* Moutarde blanche.

**Botanical Origin.**—*Brassica hirta* Moench [*Brassica alba* Hooker filius. *Sinapis alba* L.].



FIG. 191.—The Yellow Mustard, *Brassica hirta* Moench. Right lower inset represents a raceme of silique fruits.  $\times \frac{1}{2}$ .

**Part Used.**—The dried ripe seed.

**Standard of Purity.**—Not more than 5 per cent. of total ash and 1.5 per cent. acid-insoluble ash (S.R.A., F. D., No. 2, Rev. 5 (1936), U.S. Dep. Agr.).

**Habitat.**—Southern Europe and Asia.

**Plant.**—An annual herb attaining a height of about 0.6 m. and growing wild in fields throughout the United States. The leaves are all pinnatifid and arranged in alternate fashion along bristly branches. The yellow flowers appear in June and are arranged along racemes. The fruit is a bristly silique with a long sword-shaped beak. The seeds are small, yellow, sub-globular and show a minutely pitted testa.

**Production and Commerce.**—The drug is obtained from cultivated plants. The seed is sown in fertile soil in April and the plants cultivated in May. The crop is reaped as soon as the fruits have assumed a brown color. It is dried on the ground and then carried in cloths to the thresher, to avoid loss of seeds, and threshed. The quality is largely dependent upon the time of its collection. That collected in dry weather is superior. Most of the commercial supplies have been obtained from plants grown in England, Denmark, Germany, Holland, Roumania and Italy, the product being shipped in bags. The English and Danish varieties are the most highly esteemed.

**Description.**—The drug occurs in the form of entire, sub-globular seeds of a pale yellowish to yellowish-brown color from 1.5 to 3 mm. in diameter. The testa is minutely pitted and shows on one curved surface a ridge and 2 parallel grooves. Upon removing the testa a greenish-yellow oily embryo is exposed which has a curved hypocotyl and two cotyledons that are folded together lengthwise. Inodorous, unless the seed is moistened, when it is aromatic. Taste strongly pungent.

**Histology.**—Transverse sections made through the center of the seed show the following peculiarities:

1. *Spermoderm*, a narrow zone consisting of several regions, viz.: (a) Epidermis of large more or less rectangular cells, up to  $100\mu$  in diameter, whose walls swell when sections are transferred from alcohol to water, forming numerous layers of mucilage that almost obliterate the cell lumina; (b) two layers of large collenchyma cells; (c) a row of yellow, slightly lignified, palisade cells, the inner and radial walls of which are considerably thickened. The radial walls show unequal thickening, the upper portions of these taper off to form thin walls; (d) two or more layers of more or less collapsed parenchymatous cells devoid of pigment.

2. *Endosperm*, comprising (a) an outer layer of thick-walled cells, up to  $40\mu$  in diameter, which contain numerous oil globules and rounded to polygonal aleurone grains  $1-4\mu$  in diameter, and (b) several layers of compressed cells without distinct cellular structure.

3. *Embryo* (filling up the rest of the section) consisting of 2 folded cotyledons and a radicle. The cells bordering the inner sides of the cotyledons are palisade-like. The mesophyll cells of the cotyledons are elongated and contain oil globules and oblong to rounded aleurone grains having numerous globoids. Myrosin cells whose contents take a bright red color on heating sections (previously extracted with ether) with Millon's reagent are scattered through the radicle and cotyledons.

**Powdered Drug.**—Light yellow to pale brownish-yellow, developing an aromatic odor when moistened. The diagnostic elements are (1) fragments of

the outer epidermis of the testa composed of polygonal cells whose walls swell upon contact with water, forming numerous layers of mucilage that almost fill up the lumina; (2) fragments containing palisade-like stone cells “(beaker cells)” which have their inner walls and lower portions of their radial walls considerably thickened; (3) numerous fragments of the embryo containing aleurone grains and globules of oil; (4) fragments containing collenchyma cells.

**Constituents.**—Fixed oil (20–25 per cent.), *sinalbin*, a glucoside, *myrosin*, an enzyme, proteids, mucilage, etc. In the presence of moisture the enzyme, myrosin, acts on the glucoside, sinalbin, breaking it up into *acrinyl isothiocyanate* (acrinyl sulphocyanide) which is a yellowish, pungent, non-volatile oil, glucose and acid sinapine sulphate.

**Uses.**—Rubefacient, emetic and condiment. The whole yellow mustard seed is used as a constituent of whole mixed pickling spice, in pepper cabbage and other culinary dishes. Ground yellow mustard is used in mustard pickles

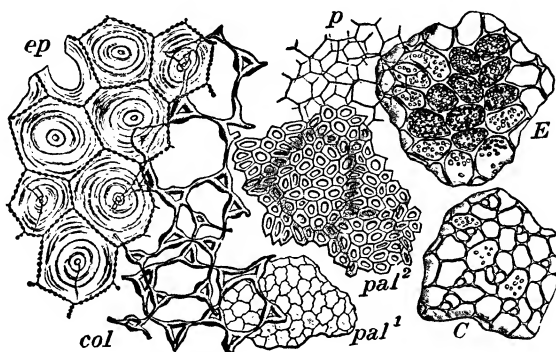


FIG. 192.—Ground White Mustard. Elements of seed in surface view. *ep*, outer epidermis; *col*, collenchyma of subepidermis; *pal¹*, outer, *pal²*, inner portion of palisade layer; *p*, parenchyma; *E*, endosperm; *C*, outer epidermis of cotyledon.  $\times 160$ . (After Winton and Winton, "Structure and Composition of Foods," J. Wiley and Sons, Inc.)

and as a flavor for meats. Powdered yellow mustard is used in the manufacture of "prepared mustard" and as an emetic.

**Average Dose.**—Emetic, 10 Gm. ( $2\frac{1}{2}$  drachms), mixed with water.

**Adulterants.**—Excessive amounts of seeds of allied plants have occasionally been found admixed with the whole mustard. The ground drug has been adulterated with wheat flour, wheat middlings and pea flour, with ground turmeric added to bring up the color and ground capsicum to provide the necessary pungency.

**Substitute.**—Chinese Colza. The seeds of *Brassica campestris* Linné var. *chinoleifera* Viehoveer have been imported from China and Japan. They resemble the yellow mustard seeds in color, but are smooth, except for a few slightly reticulated brown seeds, are somewhat smaller, and possess a cabbage-like taste. They yield *crotonyl mustard oil*, when macerated in water.

#### BLACK MUSTARD U.S.P. (*SINAPIS NIGRA*)

**Synonyms.**—(1) *Brown Mustard*, Red Mustard; (2) Chinese Mustard; *Ger.* Schwarzer Senf; *Fr.* Moutarde noire.

**Botanical Origin.**—(1) *Brassica nigra* (L.) Koch., (2) *Brassica juncea* (L.) Czerniaew or varieties of these species.

**Part Used.**—The dried ripe seed.

**Limit of Impurities.**—5 per cent. of other seeds or other foreign organic matter.

**Standard of Assay.**—Not less than 0.6 per cent. of allyl isothiocyanate (volatile oil of mustard).

**Habitat.**—Southern Europe and Asia, in waste places and along roadsides.

**Plants.**—*Brassica nigra* is an erect annual herb growing taller than the *Sinapis alba* and having alternate, slender-petioled leaves, the lower of which possess a large irregularly sinuate-dentate terminal lobe and a few small lobes coming off of the mid-rib below it. The fruits (siliques) are short, 4-angled and smooth, on short erect pedicels and appressed to the axis of the raceme. The seeds are mostly reddish-brown and minutely pitted.

\* *Brassica juncea* or Chinese Mustard is an annual herb possessing a great variety of forms. It possesses numerous large oval or obovate toothed radical leaves tapering into a narrow petiole with leafy appendages, stem leaves which are sessile, entire and oblong-lanceolate above, petioled and toothed below, small, bright yellow flowers and elongated, slender, rounded silique fruits.

**Production and Commerce.**—Brown Mustard is cultivated in Italy, Germany, England, Holland, Chile and other countries, the commercial drug being shipped to the United States from Catania, Messina, Triggiano, Palermo and Bari in Italy, from Delhi and Bombay in India, from Coquimbo in Chile and from Lisbon, Portugal. Chinese Mustard is grown in India, Southern Russia and China and is imported chiefly from Tientsin and Yokohama. The seeds of this variety are averagely larger and of a deeper brown color than those of *B. nigra*. The various mustards are shipped in burlap bags.

**Description.**—Globular, 1 to 1.6 mm. in diameter; externally varying in color from dusky red to moderate yellowish brown; testa minutely pitted or reticulate. When the hull is removed a moderate yellow to dusky yellowish-orange, oily embryo with curved radicle and 2 folded cotyledons are distinguishable; odor when dry, slight; on crushing and moistening, very irritating, strongly pungent and characteristic; taste strongly pungent and acrid.

**Histology.**—Transverse sections made through the center of the seed and examined under a microscope show a structure somewhat resembling that seen in similar sections of white mustard except for the following:

1. Collenchyma is absent and in place of this will be observed large ("giant") cells directly beneath the epidermis of the spermoderm.
2. The palisade cells are unequal in height.
3. One or two layers of pigment cells containing brownish contents that are colored blue with ferric chloride T. S. are found directly beneath the palisade layer.

**Powdered Drug.**—Light olive-brown. The diagnostic elements are (a) fragments of the epidermis of the seed coat of large polygonal cells with mucilaginous walls; (b) fragments containing stone cells (palisade cells) of unequal

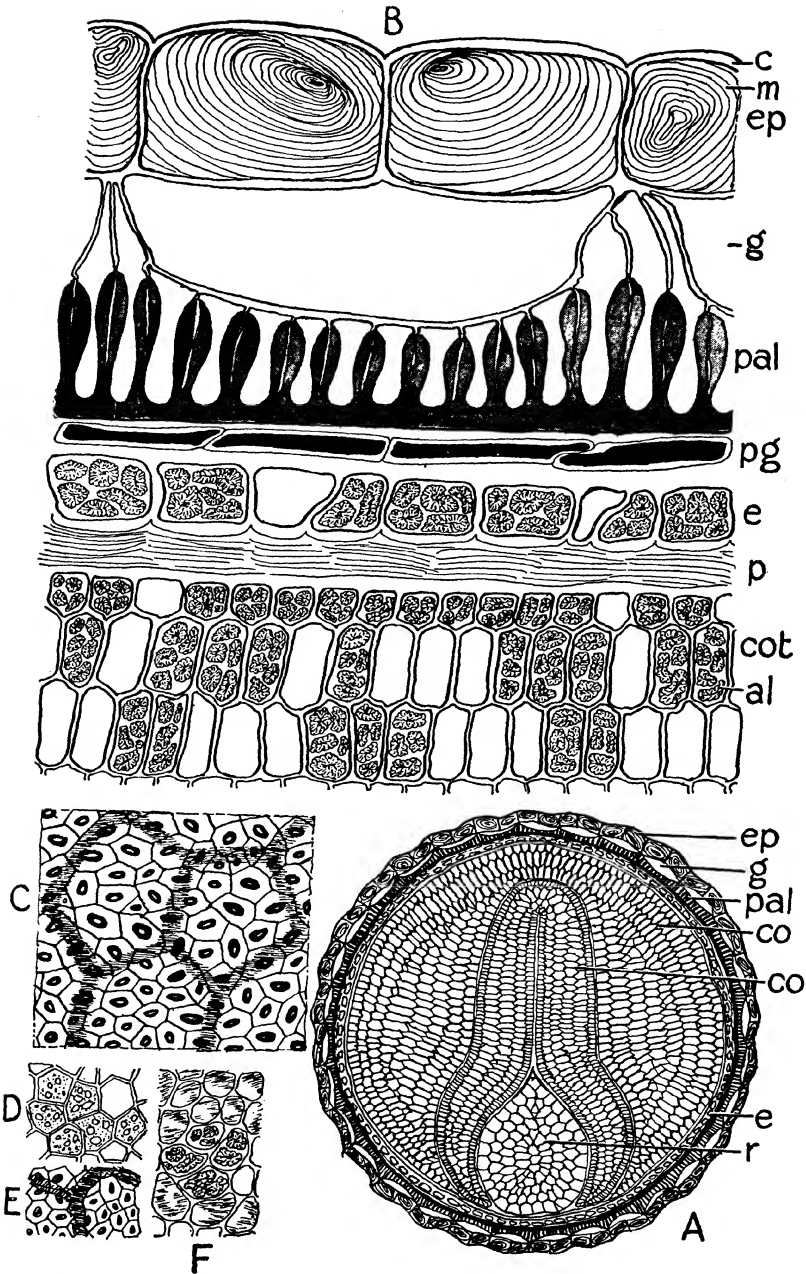


FIG. 193.—Black Mustard Seed. *A*, transverse section  $\times 95$ ; *B*, outer portion of same. enlarged; *c*, cuticle, *m*, mucilage, *ep*, epidermis, *g*, giant cells, *pal*, palisade cells and *pg*, pigment cells of seed coat, *e*, endosperm, *p*, perisperm, *co* and *cot*, cotyledon, *al*, aleurone grain, *r*, radicle; *C*, *D*, *E*, *F*, fragments found in powdered black mustard. *C* and *E*, palisade cells underlying epidermis, *D*, aleurone cells, *F*, fragment showing pigment cells (shaded) and aleurone cells of endosperm.

height, and pigment cells; (c) numerous fragments of embryo and endosperm containing small aleurone grains and oil globules.

**Constituents.**—Fixed oil (30 to 35 per cent.), *sinigrin* (glucoside), *myrosin* (enzyme), acid sinapine sulphate, proteids, mucilage, but no starch. In the presence of moisture the glucoside sinigrin is acted upon by the enzyme myrosin forming *allyl isothiocyanate* ( $C_3H_5NCS$ ) or volatile oil of mustard and glucose.

**Uses.**—Black mustard is employed externally in the form of the ground drug moistened with water as a rubefacient and counter-irritant. It is used internally as a condiment and emetic.

**Average Dose.**—Emetic, 10 Gm. ( $2\frac{1}{2}$  drachms), mixed with water.

**Preparation.**—Mustard Plaster (Emplastrum Sinapis), U.S.P.

**Adulterants.**—(1) The seeds of the wild mustard or Charlock (*Brassica Kaber* (DC.) Wheeler (*B. arvensis* B.S.P.) which, although of about the same size as Black Mustard, are darker in color (almost black) and not reticulated. The palisade stone cells of this seed become blood red, when ground black mustard adulterated with charlock is heated with a solution of chloral hydrate. (2) Common Rape seeds (*Brassica Napus* L.) are larger, up to 2.5 mm. in diameter, of a dull bluish-black, not distinctly reticulate under a low power lens but showing fine reticulations with higher magnification. Their palisade cells are nearly uniform in height and show broad lumina. (3) The seed of the Rocket or *Eruca sativa* Lam. are frequently present in Chinese mustard. These are yellow or reddish yellow, ellipsoidal and up to about 2 mm. in length.

**U.S. Dept. of Agriculture Standards for Mustard and Its Products.**—“**Mustard seed** is the seed of *Sinapis alba* L (white mustard), *Brassica nigra* (L.) Koch (black mustard), *B. juncea* (L.) Cosson, or varieties or closely related species of the types of *B. nigra* and *B. juncea*.

“*Sinapis alba* (white mustard) contains no appreciable amount of volatile oil. It contains not more than 5 per cent. of total ash nor more than 1.5 per cent. of ash insoluble in hydrochloric acid.

“*Brassica nigra* (black mustard) and *B. juncea* yield 0.6 per cent. of volatile mustard oil (calculated as allylisothiocyanate). The varieties and species closely related to the types of *B. nigra* and *B. juncea* yield not less than 0.6 per cent. of volatile mustard oil, similar in character and composition to the volatile oils yielded by *B. nigra* and *B. juncea*. These mustard seeds contain not more than 5 per cent. of total ash, nor more than 1.5 per cent. of ash insoluble in hydrochloric acid.

“**Ground mustard seed**, mustard meal, is the unbolted, ground mustard seed and conforms to the standards for mustard seed.

“**Mustard cake** is ground mustard seed, mustard meal, from which a portion of fixed oil has been removed.

“**Mustard flour**, ground mustard, ‘mustard,’ is the powder made from mustard seed with the hulls largely removed and with or without the removal of a portion of the fixed oil. It contains not more than 1.5 per cent. of starch, nor more than 6 per cent. of total ash.

**“Prepared mustard** is a paste composed of a mixture of ground mustard seed and/or mustard flour and/or mustard cake, with salt, a vinegar, and with or without sugar and/or dextrose, spices, or other condiments. In the fat, salt, and sugar free solids it contains not more than 24 per cent. of carbohydrates, not more than 12 per cent. of crude fiber, nor less than 5.6 per cent. of nitrogen, the carbohydrates being calculated as starch.” S.R.A., F.D., No. 2, Rev. 5, 1936.

**Allyl Isothiocyanate** (*Allylis Isothiocyanas*) or *Volatile Oil of Mustard* N.F. is the oil obtained by maceration with water and subsequent distillation of the dried ripe seed (free from fixed oil) of *Brassica nigra* or of *Brassica juncea* (Fam. *Cruciferae*), or prepared synthetically. It contains not less than 93 per cent. of allyl isothiocyanate ( $C_3H_5NCS$ ). It must be labeled to indicate whether it was made synthetically or distilled from either of its two common natural sources. Vesicant; when well diluted rubefacient and counterirritant in rheumatism, congestions, etc. Dose, 0.008 cc. ( $\frac{1}{8}$  minim) well diluted.

**Preparation** (unof.).—Mustard Ointment.

#### ARMORACIÆ RADIX (HORSERADISH ROOT)

**Synonyms.**—*Armoracia*; *Fr.* Raifort, Moutarde des moines; *Ger.* Meerrettig.

**Botanical Origin.**—*Armoracia lapathifolia* L.

**Part Used.**—The fresh root of cultivated plants.

**Habitat.**—Europe.

**Plant.**—A perennial herb with a long conical tap root branched toward its distal end. Radical leaves large, oblong and crenate, occasionally pinnately incised toward base; cauline leaves lanceolate. Flowers cruciform, the corolla, white. Fruit a globular silique.

**Description.**—Commercial root, up to 1 ft. in length and from one-half to 2 in. in thickness, conical, cylindrical with usually 3 or more crowns or stem bases bearing annular leaf scars at the summit; light yellowish brown; internally white and fleshy; fracture of dried root short, the fractured surface with a thin brown cork, a white middle and inner bark, a narrow distinct cambium and a finely radiated, light colored xylem; odor upon bruising pungent, somewhat mustard-like; taste somewhat sweet, hot, pungent and acrid.

**Histology.**—1. Cork of several layers of tangentially elongated, thin-walled suberous cells.

2. Cork cambium.

3. Secondary cortex consisting of an outer zone of 2 or 3 layers of thick-walled parenchyma and an inner broad zone of isodiametric parenchyma embedded in which are isolated groups of stone cells with lignified, porous and striated walls, the latter about  $8\mu$  in thickness. The stone cells occur in a variety of shapes from circular to elongate-rectangular and are up to  $107\mu$  in length and  $23\mu$  in width. Also imbedded in the cortex are groups of sclerenchyma fibers.

4. Phloem of sieve tubes and companion cells, and starch-bearing phloem parenchyma, and phloem rays.



5. Cambium of meristematic cells.

6. Xylem, a broad zone of radiate wood wedges separated by starch-bearing xylem rays. Each wood wedge shows numerous tracheids, isolated or in groups of 2 to 5 or more which are surrounded by thin-walled wood fibers or parenchyma. The tracheids as seen in radial-longitudinal section or in the grated root are reticulate with truncate or oblique end walls. The parenchyma cells are up to about  $64\mu$  in width. The starch grains are single, spheroidal, reniform to oval, and up to  $15\mu$  in diameter.

**Constituents.**—*Volatile oil* consisting chiefly of *allyl isothiocyanate*, the enzymes peroxidase and oxygenase, starch, sugars, etc.

**Uses.**—Condiment and stomachic to promote the appetite and stimulate digestion.

**Adulterants.**—The grated, bottled horseradish of commerce has been adulterated at times with grated roots of the parsnip, *Pastinaca sativa* L., the white turnip, *Brassica Rapa* L., and the beet, *Beta vulgaris* L. Parsnip root may be identified by the starch grains which are simple to 2- to 3-compound with a central cleft hilum, the individual grains being up to  $12\mu$  in diameter, by the reticulate tracheids which are  $120\mu$  to  $160\mu$  in length and up to  $50\mu$  in width and which are accompanied by very long, thin-walled, fiber cells, and also by the absence of stone cells.

White turnip root possesses large thin-walled parenchyma cells, up to  $170\mu$  in diameter, which are devoid of starch, reticulate tracheids shorter than in horseradish and from 30 to  $50\mu$  in diameter and having more rounded markings on their walls than the tracheids of the latter. Stone cells are absent.

#### HAMAMELIDACEÆ (WITCH HAZEL FAMILY)

Shrubs or small or large trees. Leaves simple, alternate and pinnately veined; stipules deciduous to caducous, paired and slightly fused at the bases of petioles. Flowers frequently yellow to yellowish-white, in axillary clusters or heads or spikes, hermaphrodite or monœcious; sepals and petals 5 to 4, rarely indefinite, superior (petals absent in *Fothergilla*); stamens twice as many as the petals but the outer row alone fertile, the inner row being more or less barren and scale-like; gynœcium of 2 carpels united below. Fruit a 2-beaked, 2-celled, woody capsule dehiscing at the summit, with a bony seed in each cell, or several, only 1 or 2 of them ripening.

#### STORAX U.S.P. (STYRAX)

**Synonyms.**—*Liquid Storax*, Sweet Gum; *Ger.* Flussiger Storax; *Fr.* Styrax liquide.

**Botanical Origin.**—*Liquidambar orientalis* Miller and *Liquidambar styraciflua* Linné.

**Part Used.**—Balsam obtained from the trunk.

**Habitat.**—*L. orientalis* is native to forests of Asia Minor; *L. styraciflua* to North America, Central America and northern South America.



FIG. 194.—*Liquidambar orientalis*. 1. Young shoot with flowers. 2. Bract of male capitulum. 3. Staminate flower. 4. Section of same. 5. Head of pistillate flowers. 6. Branch with fruit. 7. Section of a head of fruit. 8. Mature leaf. (After Bentley and Tri-  
men.)

**Plants.**—*Liquidambar orientalis* which yields Levant Storax is a tree growing to the height of 10 to 15 m. and bearing palmately 5-lobed, the lobes usually having 2 to 4 small lobes, serrate, glabrous leaves and heads of yellowish flowers. The fruit is a spherical head of beaked capsules, each capsule with 1- or 2-winged seeds.

*Liquidambar styraciflua* which yields the American Storax is a pyramidal tree attaining a height of 15 to 40 m. Its leaves are palmately 5- to 7-lobed, the lobes being serrulate and acuminate. They are glabrous on their upper surface, their lower surface, however, showing tufts of reddish-brown hairs in the axils of the principal veins.

**Production and Commerce.**—Storax is a pathological product which forms in the young wood of the trunk of *Liquidambar* species as a result of mechanical injury. The cambium is stimulated by the injury to produce new wood containing schizolysigenous reservoirs in which the balsam is secreted.

**Levant or Asiatic Storax** is produced in the forests of southwestern Asia Minor from the *Liquidambar orientalis*. The process of extracting the balsam in this region is carried on as follows: In the early part of the summer the trunk of the Oriental Sweet Gum is bruised on one side. As a result of this injury storax forms in the young layers of wood and oozes into the wounded bark. In autumn, this bark, which is more or less saturated with balsam, is stripped off and the balsam pressed out. The bark is then boiled in water within copper kettles and again pressed, and the remainder of the balsam thus extracted. The balsam is poured into barrels, goat skins or cans for shipment. It is imported from Turkey and Italy.

**American Storax** is produced chiefly in British Honduras but is also collected in small quantities in North Carolina and other southern states. Great forests of the *Liquidambar styraciflua* exist in the mountainous country of British Honduras. The balsam exudes into pockets on the trunk which hold from 2 to 8 pounds each. These pockets are located by native collectors, through the excrescences formed on the bark. If the pockets are near the base of the tree, the balsam is collected without destroying the tree, if higher up, the tree is felled. The native collectors make an incision in the excrescence and insert a gutter, the free end of which leads to a container. The thick balsam flows out slowly and is collected. When full the contents of the containers are poured into larger containers holding 50 pounds each. These are carried on the shoulders of native laborers for long distances and then placed on the backs of mules for the balance of the journey to the shipping center. The product is exported from British Honduras and Guatemala in tin cans.

During 1947, 90,712 lbs. of storax were imported into this country.

In the Southern United States the method of production is as follows: From March to May shallow cuts are made in the branches. These develop into resin pockets in which from 1 to 4 pounds of balsam accumulates. In some instances the trunk is girdled and after yellowish drops have exuded and hardened, the balsam is collected. Frequently a cut is made in a naturally formed

excrecence and the exudation conducted to a container by means of a gutter. The balsam is then placed in cans for shipment.

**Description.**—A semi-liquid, grayish to grayish-brown sticky, opaque mass which deposits on standing a heavy, dark brown stratum (*Levant Storax*); or a semi-solid to solid, yellowish-brown mass, softened by gentle warming (*American Storax*); transparent in thin layers; odor balsamic, characteristic; taste acrid.

It is insoluble in water, but completely soluble, save for accidental impurities, in an equal weight of warm alcohol; almost completely soluble in ether, acetone, benzene and carbon disulphide. When heated on a water-bath, Storax becomes more fluid, and if it is then agitated with warm, purified petroleum benzin, the supernatant liquid, on being decanted and allowed to cool, is not darker than pale yellow and deposits white crystals of cinnamic acid and cinnamic esters. The separated crystals, when heated with diluted sulfuric acid and potassium permanganate, evolve an odor resembling that of oil of bitter almonds.

**Constituents.** (*Levant Storax*).—The *resin alcohols*,  $\alpha$ -storesin and  $\beta$ -storesin, which occur partly free and partly combined with cinnamic acid and partly with sodium; *ethyl cinnamate*, *cinnamyl cinnamate* (styracin), a colorless aromatic liquid called styrol, *phenyl-propyl cinnamate*, *benzoic acid*, *vanillin*, *free cinnamic acid* (17 to 23 per cent.), etc. Total esters of cinnamic acid, 24 to 25 per cent.

*American Storax* contains *styresinol* both free and as the *cinnamic acid ester*, *free cinnamic acid* (12.6 per cent.), *cinnamyl cinnamate*, *phenyl-propyl cinnamate*, styrol, vanillin, etc. Total resin esters 34.76 per cent.; total cinnamic acid, 28.02 per cent.

**Uses.**—Storax is used as a stimulating expectorant in compound tincture of benzoin and other pharmaceutical preparations. It is also employed as a perfume in soaps and toilet preparations.

**Average Dose.**—1 Gm. (15 grains).

**Preparation.**—Compound Benzoin Tincture, U.S.P., 2 cc. (30 minims).

#### HAMAMELIS LEAF N.F. (HAMAMELIDIS FOLIUM)

**Synonyms.**—*Witch-hazel Leaves*, Striped Alder, Winter Bloom; *Ger.* Zauberhasel; *Fr.* Hamamélis.

**Botanical Origin.**—*Hamamelis virginiana* Linné.

**Part Used.**—The dried leaf.

**Purity Rubric.**—Not more than 5 per cent. of stems of the plant or more than 2 per cent. of other foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—In damp woodlands of North America from Nova Scotia to Florida, west to Minnesota and Texas.

**Plant.**—A tall shrub or small tree attaining the height of 4.6 m. The leaves are alternate, stipulate, short-petioled, inequilaterally ovate or rhomboid-ovate, with oblique base and sinuate or sinuate-dentate margin. The flowers are

yellow and appear in axillary clusters during autumn, as the leaves fall and at about the same time as the ripening of the fruits from blossoms of the previous year. The fruit is a 2-beaked, 2-celled, woody capsule dehiscing loculicidally from the summit, each cell containing a single black seed.

**Production and Commerce.**—Witch Hazel leaves should be collected in autumn when they contain the most tannin and carefully dried. The commer-

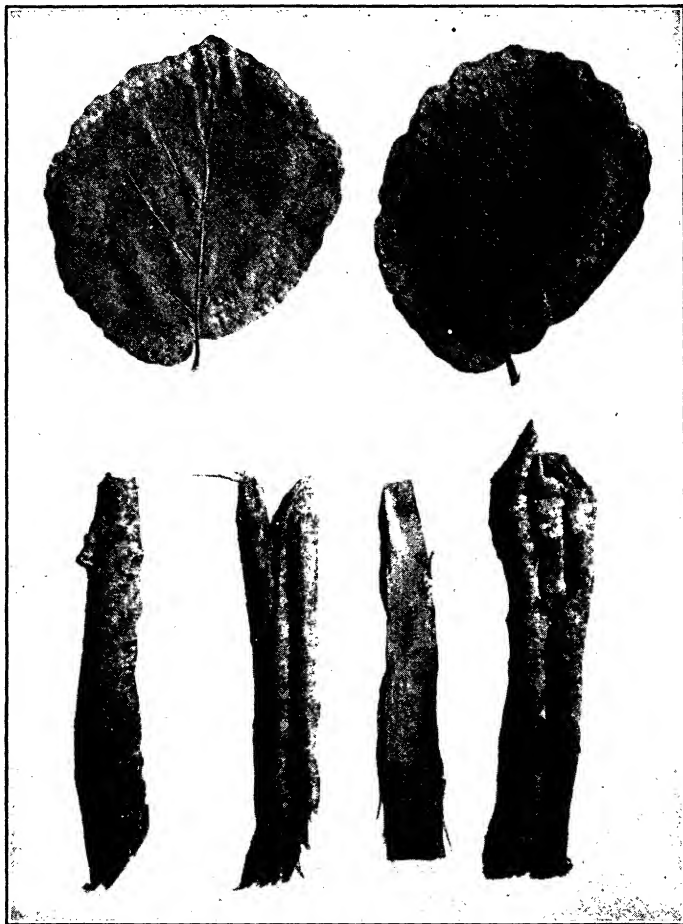


FIG. 195.—Witch Hazel leaves and bark,  $\times \frac{1}{2}$ .

cial supplies used in this country are collected in Maine and from Virginia to Tennessee and South Carolina.

**Description.**—Petiole from 1 to 1.5 cm. in length; lamina usually broken, but when entire, broadly ovate or rhomboid-ovate, inequilateral, mostly from 8 to 12 cm. in length; summit either acute, rounded or acuminate; base slightly cordate and oblique; margin sinuate or sinuate-dentate; upper surface light olive-brown to moderate olive-green, occasionally dark brown, with a few stiff hairs; lower surface shiny light green or grayish-green, slightly hairy, with

prominent midrib and veins, the secondary veins coursing straight toward the margin; odor slight; taste astringent, slightly aromatic and bitter.

**Powdered Drug.**—Yellowish-brown to light yellow; epidermal fragments with narrowly elliptical stomata from 23 to 35 $\mu$  in length and with 2 to 4 neigh-

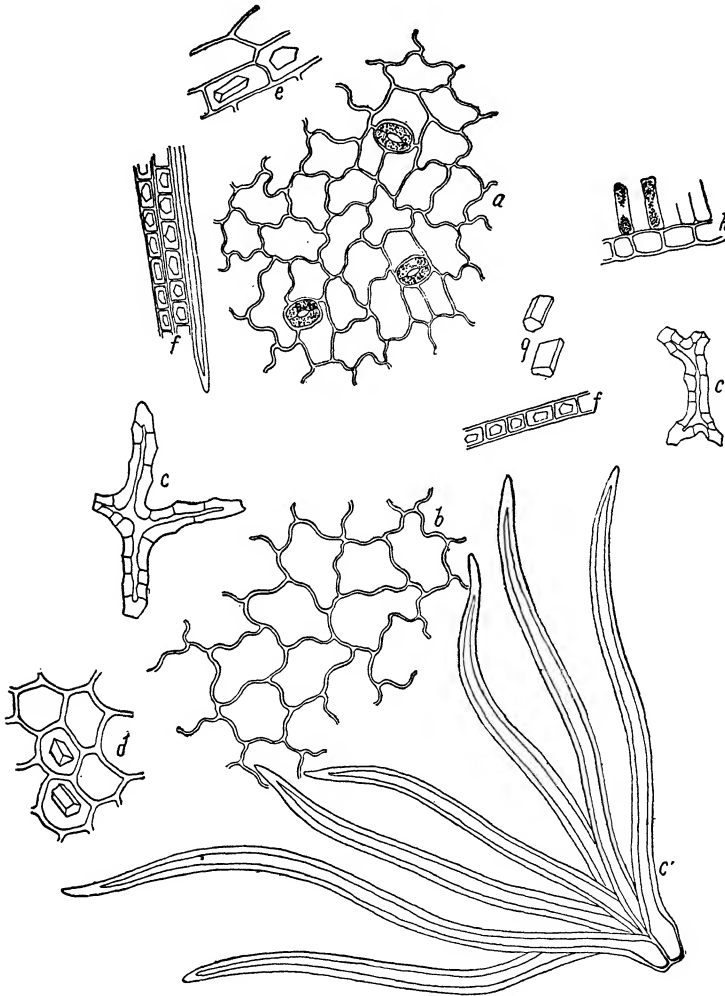


FIG. 196.—Powdered Hamamelis. (a) Lower epidermis; (b) upper epidermis; (c) idioblast from leaf blade; (c') stellate trichome; (d) parenchyma with crystals; (e) parenchyma; (f) crystal fibers; (g) prismatic crystals; (h) epidermis of leaf, upper with subjacent palisade parenchyma. (Schneider.)

bor-cells; non-glandular hairs unicellular up to 500 $\mu$  in length with thick walls and narrow lumina, many curved, arranged in stellate groups of from 4 to 12 cells united at the base; many cells of spongy parenchyma containing tannin masses; sclerenchyma fibers, lignified, thick-walled with adhering crystal fibers; monoclinic prisms of calcium oxalate from 10 to 35 $\mu$  in length in cells of mesophyll or in crystal fibers associated with strongly lignified pericyclic fibers;

tracheæ mostly spiral and associated with thick-walled wood fibers which take the red color with phloroglucin-hydrochloric acid.

**Constituents.**—*Tannin*, a trace of *volatile oil*, bitter principle, gallic acid, etc.

**Uses.**—Astringent and hæmostatic.

**Average Dose.**—2 Gm. (30 grains).

**Preparation.**—Hamamelis Leaf Fluidextract (Fluidextractum Hamamelidis Folii), 2 cc. (30 minims).

**Note.**—Hamamelis Water N.F. (Aqua Hamamelidis) also known as Witch-hazel Water and Distilled Witch Hazel Extract is obtained by macerating a weighed amount of the recently cut and partially dried dormant twigs of *Hamamelis virginiana* for a day in about twice their weight of water and subsequently distilling until not more than 850 cc. of distillate is obtained for each 1000 Gm. of the twigs taken and adding 150 cc. of alcohol to each 850 cc. of distillate, and thoroughly mixing.

### ROSACEÆ (ROSE FAMILY)

Herbs, shrubs, or trees mostly of temperate regions. Stem and branches upright or creeping (Strawberry, Cinquefoil), herbaceous to woody. Leaves alternate, stipulate (stipules green, persistent to scaly deciduous), compound, condensing to "simple." Flowers regular, pentamerous; sepals and petals 5, rarely 4, inferior to ovary, becoming by stages superior to it. Sepals green, at times with epicalyx (Strawberry, Cinquefoil, Koussou, etc.), persistent around fruit. Petals usually yellow to white or to pink, crimson, rarely purple, roseaceous, deciduous. Stamens indefinite, perigynous (Strawberry, etc.), to semi-epigynous (Rose, Peach, etc.), and epigynous (Apple, Pear). Pistil apocarpous with many (Strawberry, Rose) carpels or fewer to 5 (Apple), or 2 to 1 (Plum, Cherry), becoming falsely fused by union with upgrowing receptacle (Hawthorns, Apple). Fruit a collection of achenes on dry (Cinquefoil) or succulent receptacle (Strawberry), or dry follicles (Bridal Wreath), or drupels (Blackberry), or a drupe (Peach, Plum, Cherry), a hip (Rose), or a pome (Apple, Quince, Pear). Seeds exalbuminous, embryo filling seed cavity.

Among the histological features of this family, the following are noteworthy: Calcium oxalate in the form of monoclinic prisms, rosette aggregates or rarely as styloids (*Quillaja*), non-glandular and glandular hairs, secretion cells containing tannin or mucilage, sclerenchyma fibers or stone cells or both in the pericycle of woody species, wood fibers of the tracheid type and tracheæ with bordered pores and scalariform thickenings.

### ROSE N.F. (ROSA)

**Synonyms.**—*Red Rose Petals*, *Rosa Gallica*, Red Rose, *French Rose*, Provins Rose: *Ger.* Essigrose, Sammtrose; *Fr.* Rose rouge, Rose de Provins.

**Botanical Origin.**—*Rosa gallica* Linné.

**Part Used.**—The dried petals collected just before the expansion of the flowers.



FIG. 197.—*Rosa gallica*. 1. Flowering shoot. 2. Section of flower with petals removed. 3. Petal. 4. A carpel. 5. Anthers. 6. Fruit (A hip). (After Bentley and Trimen.)



**Purity Rubric.**—Nor more than 1 per cent. of foreign organic matter; it yields not more than 1 per cent. of acid-insoluble ash.

**Habitat.**—Western Asia and southern Europe. Cultivated widely. Naturalized in the United States along roadsides and in thickets.

**Plant.**—A shrub attaining the height of 1 to 1.5 m. It has numerous stems armed with prickles, alternate, imparipinnate leaves, each having 3-5 broadly elliptic leaflets which are obtuse at apex, cordate at base and glandular-serrate along the margin. The flowers are large, usually double, with velvety, purplish-red petals and very fragrant. The fruit is an orange-red, oblong hip containing achenes.

**Production and Commerce.**—The drug is collected from plants that are cultivated. Just before the flower buds expand they are cut off with a sharp knife near the base of the corolla, the lower clawed portion being usually left behind. They are carefully but rapidly dried by artificial means, garbled and packed in burlap bags or cases for shipment. The chief source of supply is southern France. Small amounts have come from Tunis and Bombay. The drug should be stored in tightly closed containers protected from light.

**Description.**—The drug consists of a mixture of separate and broken petals and entire cones of numerous imbricated petals. Petals broadly ovate, summit retuse, margin entire and somewhat recurved, base obtuse; externally of a purplish-red to weak red color in upper part, yellowish-brown to yellowish-orange in the claw; texture velvety; when dry brittle; odor rose-like; taste astringent and slightly bitter.

**Constituents.**—*Rosa-tannic acid*, quercitrin, *volatile oil*, coloring matter, etc.

**Uses.**—Astringent and vehicle, chiefly in the form of fluidextract, honey or infusion of rose.

**Preparation.**—Pilulæ Aloes et Mastiches N.F. (2 pills).

#### ROSA CENTIFOLIA (PALE ROSE)

**Synonyms.**—Cabbage Rose, Moss Rose; *Ger.* Blasse Rose; *Fr.* Rose pâle.

**Botanical Origin.**—*Rosa centifolia* Linné.

**Parts Used.**—(1) The dried petals and nearly mature flower buds. (2) The fresh flowers.

**Habitat.**—Western Asia.

**Plant.**—An erect branched shrub growing to the height of 1 to 2 m. with prickly stems, the prickles being hooked; petioled, imparipinnate leaves with 5 to 7 serrate, acute leaflets and large, double, pink flowers with persistent calyx. The fruit is an orange-red to scarlet, oblong hip containing numerous achenes.

**Collection and Commerce.**—The flower buds are collected in their nearly mature but unexpanded condition and carefully dried. The commercial supplies used in this country come from Germany and Austria.

**Description.**—The drug usually occurs as a mixture of unexpanded cone-shaped flower buds and some petals. Petals obovate or obcordate, retuse, pink; odor fragrant and rose-like; taste sweetish, slightly bitter and astringent.

**Constituents.**—*Volatile oil*, mucilage, *rosa-tannic acid*, quercitrin, coloring matter, etc.

**Uses.**—In the manufacture of Stronger Rose Water U.S.P., prepared by distilling the fresh flowers of *Rosa centifolia* with water and separating the excess volatile oil from the clear aqueous portion of the distillate. Stronger Rose Water enters into *Aqua Rosæ* or Rose Water U.S.P. The fresh flowers are one of the sources of rose oil. The dried drug is used in sachets and potpourris.

#### ROSE OIL U.S.P. (OLEUM ROSÆ)

**Synonyms.**—*Otto of Rose*, Attar of Rose, *Ger.* Rosenöl; *Fr.* Essence de rose.

**Definition.**—The volatile oil distilled with steam from the fresh flowers of *Rosa gallica* L., *Rosa damascena* Miller, *Rosa alba* L., and *Rosa centifolia* L., and varieties of these species (Fam. *Rosaceæ*).

Rose Oil is distilled chiefly from the fresh flowers of *Rosa damascena* or Damascus Rose, *Rosa alba*, or White Rose, and *Rosa gallica* or Red Rose. It is permitted to be obtained also from *Rosa centifolia*. *Rosa damascena* and *Rosa alba* are shrubs cultivated mainly on the southern side of the Balkan Mountains in Bulgaria, the town of Kizanlik being the main center of production. It is a colorless or yellowish liquid, viscous at 25°C., with a characteristic rose odor. If kept in a cool place it changes to a translucent crystalline mass, which may be liquefied by warming. It should be packaged and stored in well filled, tight containers. It is used to perfume ointments and other galenicals, especially cosmetics.

**Preparation.**—Rose Water Ointment, U.S.P.

#### WILD CHERRY U.S.P. (PRUNUS VIRGINIANA)

**Synonyms.**—*Wild Black Cherry Bark*, Wild Cherry Bark, Rum-, Whiskey- or Cabinet Cherry; *Ger.* Wildkirchenrinde; *Fr.* Ecorce de cerisier de Virginie.

**Botanical Origin.**—*Prunus serotina* Ehrhart (*Prunus virginiana* Miller).

**Part Used.**—The carefully dried stem bark. Borke, if present, should be removed.

**Habitat.**—Eastern and central North America, along fences, on borders of forests and other exposed or partly exposed places.

**Plant.**—A tree growing to a height of 50 to 110 feet with a trunk diameter of 2 to 5 feet. The bark on young trunks is glossy, smooth, reddish-brown and marked with numerous white, horizontally-elongated lenticels; that on young twigs is marked with numerous pale, round lenticels which in time become elongated horizontally. The bark on old trunks is rough, black and scaly. The leaves are alternate, simple, oblong or lanceolate-oblong, 2 to 5 inches long, acuminate at apex, tapering or rounded at base, serrate along margin. The flowers are perfect and white, appearing in May or June on elongated racemes. The fruit is a purplish-black drupe.

**Production and Commerce.**—The commercial bark is gathered from spring to autumn, carefully dried and stored in closed containers. Two varieties of Wild Cherry bark occur in commerce, the rossed and the unrossed barks.

**Rossed bark** is that which has been deprived of its periderm (corky outer layer). This bark possesses a greenish-brown to light brown outer surface and often scars of lenticels. **Unrossed bark** represents the entire bark. The term



FIG. 198.—*Prunus serotina*. Branch bearing leaves and inflorescences and pieces of bark from same tree.

“borke” has been applied to the thick, rough, blackish outer bark found on older parts of the trunk. This should be removed. The commercial supplies of the drug come largely from Virginia, Indiana, Michigan and North Carolina.

**Description.**—In transversely curved strips or chips of variable length and breadth and from 0.5 to 8 mm. in thickness; outer surface of rossed bark moderate brown to light olive-brown, smooth, except for numerous lenticel-scars; outer surface of unrossed bark, weak reddish-brown and glossy (young bark) to olive-gray (older bark); smooth, except for numerous lenticels which vary

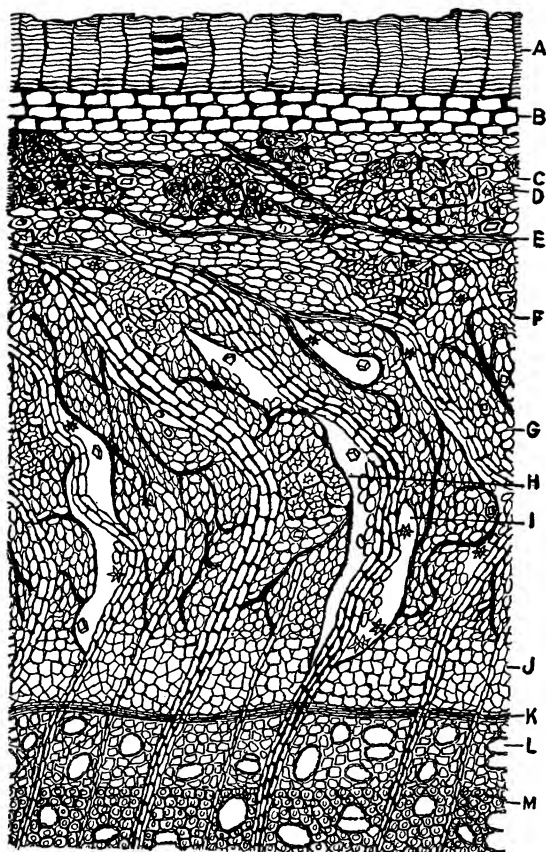


FIG. 199.—Transverse section of bark of *Prunus serotina* Ehrhart (Wild Black Cherry) with adhering wood. Periderm (A); collenchyma (B); cortex (C), containing starch and monoclinal prisms of calcium oxalate; stone cells in pericycle (D); sclerenchyma fibers (E); medullary-ray (F); soft bast (G); mass of stone cells (H); fissure between medullary-ray and bast (I); young phloem (J); cambium (K); trachea in newly formed wood (L); wood fibers in mature wood (M).

from small and round on bark of young stems to transversely elongated and 3 to 5 mm. in length on bark of older stems, or outer surface roughened and flaky with light-colored lichens; the cork readily peeling off and exposing a greenish middle bark; fracture short, granular and uneven; inner surface weak reddish-brown to weak orange, with fine reticulate striations and numerous minute fissures; odor distinct, resembling that of bitter almonds, when moistened with cold water; taste astringent, aromatic and bitter.

**Histology.**—Sections of this bark show the following microscopical features:

1. *Cork* of varying thickness interrupted by lenticels (absent in rossed bark).
2. *Phellogen* of meristematic cells.

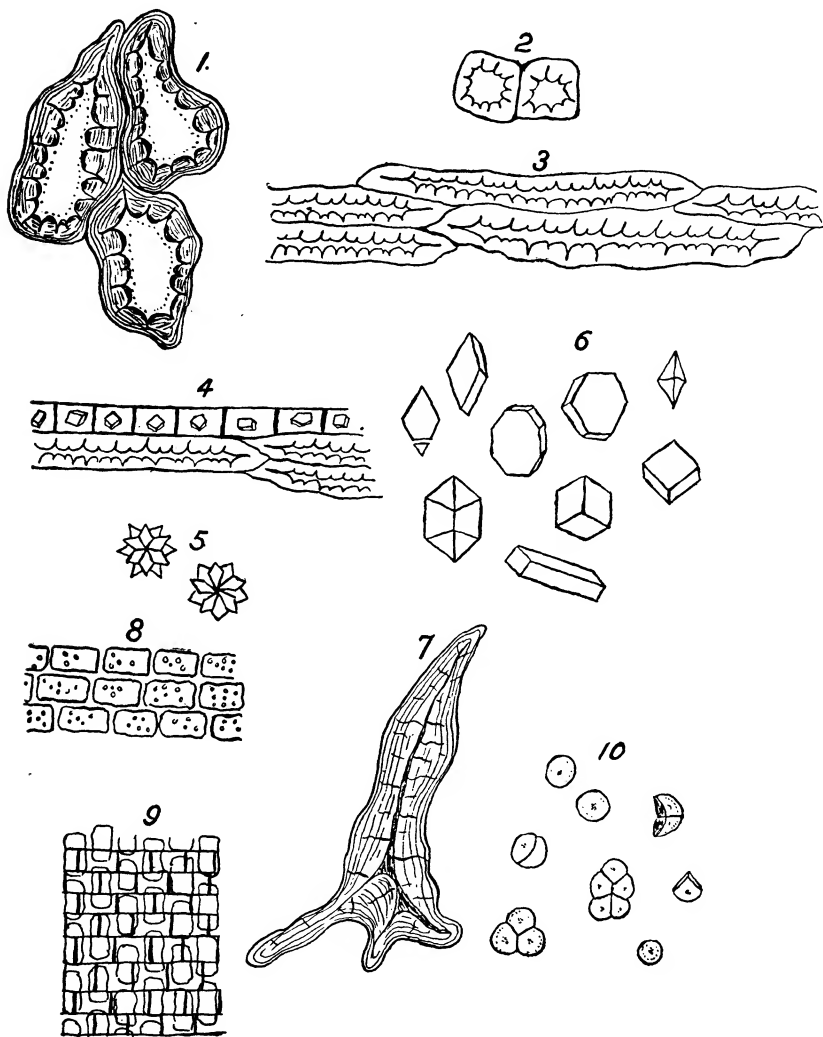


FIG. 200.—Powdered *Prunus Virginiana* (*Prunus serotina* bark). (1), (2) Stone cells; (3) bast fibers; (4) crystal fiber adhering to bast fibers; (5) rosette aggregates of calcium oxalate; (6) monoclinic prisms of calcium oxalate; (7) typical, heavily lignified, branching, stone cell; (8) starch parenchyma; (9) medullary-ray cells crossing parenchyma; (10) various types of starch grains found in drug.

3. *Phelloderm* of tangentially-elongated cells, cut off from the phellogen and containing chloroplastids in younger bark.

4. *Primary cortex*, a narrow zone of tangentially-elongated cells containing starch or tannin, occasionally monoclinic prisms of calcium oxalate.

5. *Pericycle*, containing a nearly continuous zone of stone cell clusters and some fibers. Many of these stone cells when isolated by Schulze's maceration process are found to show branching. They all show thick, lignified, porous walls. A few monoclinic prisms may be seen in parenchyma cells of this region, rarely rosette aggregates.

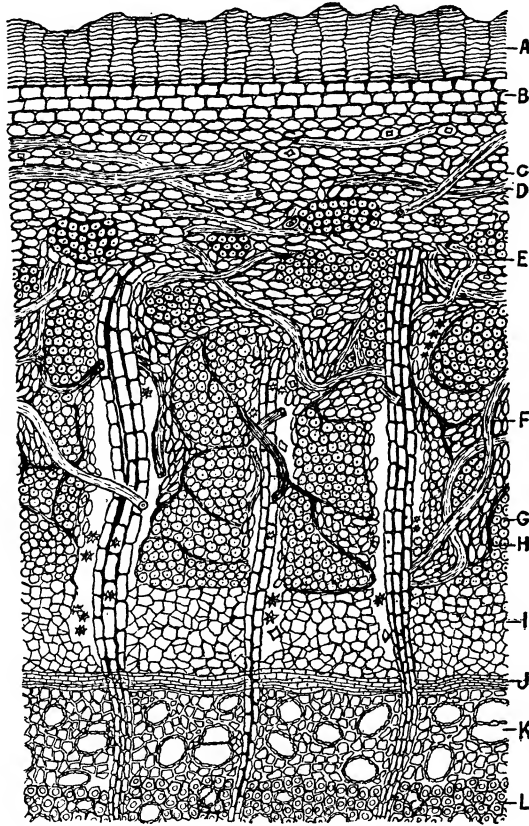


FIG. 201.—Transverse section of the bark of *Prunus Virginiana* Linné (Choke Cherry). Periderm (A); collenchyma (B); cortex (C) containing starch, rosette aggregates and monoclinic prisms; tortuous sclerenchyma fiber (D); medullary-ray (E); sclerenchyma fiber (F); group of bast fibers (G); compressed sieve tissue (H); young bast (phloem) (I); cambium (J); trachea in recently formed wood (K); wood fibers of mature wood (L).

6. *Phloem*, a relatively broad zone separated by numerous curved fissures into more or less scythe-shaped masses, each generally consisting of a curved medullary-ray and a phloem patch. The starch-containing medullary rays range from 1 to 6, rarely 8 cells in width, as observed in tangential sections. The phloem patches adhere to the medullary-rays and are composed of a matrix of phloem cells and sieve tissue, the phloem cells containing starch, tannin or crystals. Masses of stone cells and simple or branched bast fibers accompanied by crystal fibers containing monoclinic prisms occur in each phloem patch. Rosette aggregates of calcium oxalate occur in groups or singly, mainly in the

cells adjoining the medullary rays or in the fissures between the medullary-rays and phloem strands. In these regions monoclinic prisms also occur. The bast fibers are both simple and branched in character.

**Powdered Drug.**—Light brown to light yellowish-brown; numerous thick-walled, lignified, simple or branched stone cells and bast fibers, the latter accompanied by crystal fibers containing monoclinic prisms of calcium oxalate; fragments of parenchyma containing tannin and starch; starch grains, simple and compound, the simple grains more or less spheroidal and from  $2\mu$  to  $15\mu$  in

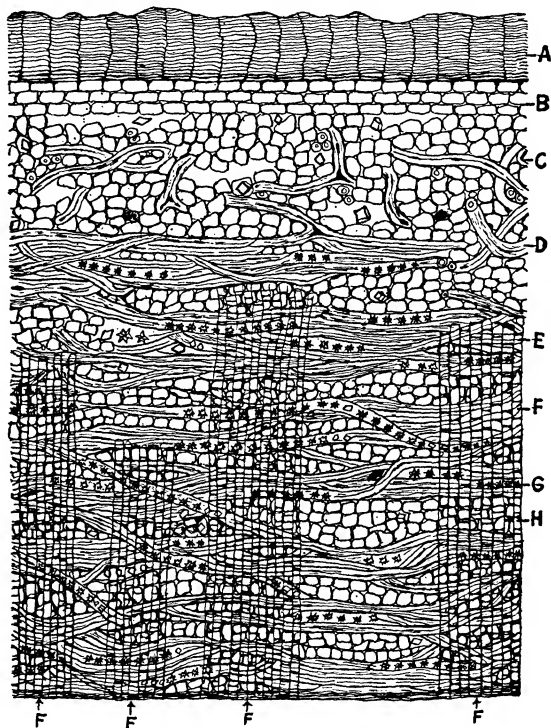


FIG. 202.—Radial-longitudinal section of bark of *Prunus virginiana* Linné (Choke Cherry). Periderm (A); collenchyma (B); cortex, containing typical monoclinic prisms of calcium oxalate (C); sclerenchyma fiber (D); bast fibers and rosette aggregates of calcium oxalate, the latter arranged either singly or in longitudinal rows (E, G); soft bast (H); medullary-rays (F).

diameter; fragments of reddish-brown to yellowish-orange cork; rosette crystals and monoclinic prisms of calcium oxalate from 10 to  $75\mu$  in diameter.

**Storage.**—Wild Cherry bark should be stored in well-closed containers protected from light and moisture.

**Constituents.**—*l*-mandelonitrile glucoside, a ferment called *emulsin*, *tannin*, tri-methyl-gallic acid, *l*-mandelic acid, dextrose, etc. In the presence of moisture, the ferment *emulsin* acts upon the *lævo*-mandelonitrile glucoside, hydrolyzing it to *hydrocyanic acid*, *benzaldehyde* and glucose.

**Uses.**—Wild Cherry is employed as a stimulating expectorant, simple bitter and as a flavoring agent.

**Average Dose** (unof.).—2 Gm. (30 grains).

**Preparations.**—Wild Cherry Syrup, U.S.P., 10 cc.; Wild Cherry Fluidextract, N.F., 2 cc.; Compound Taraxacum Elixir, N.F. (From Fldext.)

**Adulterants and Substitutes.**—(1) Bark of *Prunus virginiana* Linné, commonly known as Choke Cherry. This differs from the bark of *Prunus serotina* chiefly by showing no stone cells in pericycle, by having medullary rays which range from 1 to 4 cells in width as observed in tangential sections, and by showing more rosette aggregates of calcium oxalate in the phloem than monoclinic prisms.

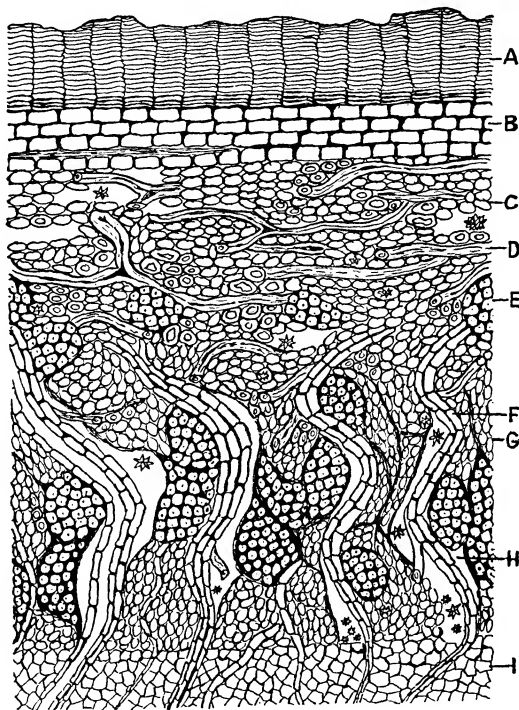


FIG. 203.—Transverse section of the bark of *Prunus Cerasus* Linné. Periderm (A); collenchyma (B); cortex (C), containing starch, few rosette aggregates and no monoclinic prisms of calcium oxalate; tortuous, branching sclerenchyma fibers (D); group of bast fibers (E); medullary-ray (F); soft bast (G); fissure between medullary-ray and bast (H); young phloem (I).

(2) Bark of *Prunus Avium* L., commonly known as Sweet Cherry. This is smoother and lighter colored, being glossy and of a light reddish-brown on twigs and reddish-gray on trunk. The lenticels are fewer and more elongated than those of the 2 previously mentioned species. Microscopically, it shows a very narrow cortex and pericycle in which calcium oxalate occurs mostly as rosette aggregates, rarely as monoclinic prisms. In the phloem occur numerous scattered and tortuous bast fibers giving the bark a more fibrous fracture than that of any species of *Prunus* examined by the writer. The medullary rays are oblique and wavy, when examined in cross sections, and range from 1 to 4 cells in width.



(3) Bark of *Prunus Cerasus* L., commonly known as Sour or Morello Cherry. This bark is smooth, darker than either of the preceding cherry barks of the same age. The lenticels are fewer and larger than those of the *P. serotina* bark of similar age. It differs microscopically from the official bark by having a broader cortex, shorter and more irregular medullary rays, in possessing smaller and more scattered groups of bast fibers, and in containing very few calcium oxalate crystals which occur as rosette aggregates, never as monoclinic prisms.

(4) The ground drug has been adulterated with wood of the same tree.

#### CHERRY JUICE N.F. (SUCCUS CERASI)

**Synonyms.**—Sour Cherry, Morello Cherry; *Ger.* Sauerkirsche.

**Botanical Origin.**—Cultivated varieties of *Prunus Cerasus* L.

**Part Used.**—The liquid expressed from the fresh, ripe fruit.

**Standard of Assay.**—Not less than 1.0 per cent of malic acid.

**Habitat.**—Asia Minor and probably southeastern Europe. Cultivated in America.

**Plant.**—A round crowned tree which suckers readily from the roots. Its bark is gray to grayish brown with prominent lenticels, its leaves ovate to obovate or ovate-lanceolate, acute or acuminate at apex, and serrate along the margin, its flowers appearing before the leaves or with the leaves in small, axillary umbels, its fruit a spherical, depressed-globular, or cordate, red fruit with a sub-globular stone.

**Production.**—Two well marked groups of sour cherries are grown in this country, viz.: (1) the *Amarelles*, whose fruits are pale red, possess colorless juice and are somewhat flattened on the ends and (2) the *Morellos* whose fruits are dark red, possess colored red juice and are spherical to cordate. Most of the sour cherries cultivated belong to the Amarelle group and are produced in Michigan, New York, Wisconsin and California.

**Description of Fruit.**—Drupe spherical, depressed, globose or cordate, with a circular elevated scar at the summit representing the remains of the style, and a circular scar at the base representing the point of attachment of the pedicel, up to about 20 mm. in length and 18 mm. in breadth; externally pale red to dark red, glabrous; internally exhibiting a membranous epicarp, a fleshy mesocarp containing a colorless, light red to dark red juice, and a subglobose, stony, light brown endocarp within which occurs a globular, exalbuminous seed, the latter with a light brown seed coat enveloping a fleshy, oily embryo; odor of the crushed fruit characteristically aromatic: taste pleasantly acidulous.

**Description of Cherry Juice.**—A clear liquid with an aromatic, characteristic odor and a sour taste. The color of the freshly prepared juice is red to reddish orange; sp. gr. 1.045 to 1.075 at 25°C.; hydrogen-ion concentration between pH 3.0 and pH 4.0.

**Preparation.**—The unpitted sour cherries are washed, stemmed and coarsely crushed in a grinder so as to break the pits but not mash the kernels; 0.1 per cent. of benzoic acid is dissolved in the mixture and the whole allowed to stand at room temperature until a small portion of the filtered juice forms a clear

solution when mixed with one-half of its volume of alcohol. The juice is then pressed out from the mixture and filtered. It is preserved in tight, light-resistant containers.

**Constituents.**—*Citric acid, amygdalin, emulsin, malic acid, tannin, dextrose, sucrose, quercetin, anthocyanin, etc.*

**Use.**—Cherry Juice is used in the preparation of a pleasantly flavored syrup which is used as a vehicle.

**N.F. Preparations.**—Cherry Syrup; Ephedrine Sulfate Syrup (from Cherry Syr.), 4 cc. (1 fl. dr.).

### RUBUS (RUBUS)

**Synonyms.**—Blackberry Bark; *Ger.* Brombeerrinde; *Fr.* Ecorce de Ronce noir.

**Botanical Origin.**—The section *Eubatus* Focke of the genus *Rubus* Linné.

**Part Used.**—The dried bark of the rhizome and roots.

**Habitat.**—In fields and woodlands of the United States.

**Plants.**—The section *Eubatus* of the genus *Rubus* comprises a long series of shrubby and usually prickly plants, commonly called “blackberries” and “dewberries.” The blackberries are erect in habit, usually possessing strong, woody, reclining stems together with long, repent stolons. The dewberries are prostrate and trailing in habit with repent or decumbent stems which give rise, at their nodes, to erect flowering canes. Both the blackberries and the dewberries have mostly pinnately 5-foliate leaves on the first year’s growth and chiefly pinnately 3-foliate leaves on the flowering canes. Their fruits are etærios, each consisting of a number of drupelets which adhere, when ripe, to the receptacle. Considerable of the Blackberry Bark of commerce has been yielded by the species whose descriptions follow:

*Rubus villosus* Ait. or Dewberry is a low-growing, nearly prostrate shrub found in dry fields and open places from southern Maine to Virginia and as far west as Kansas. Its stems are woody and bear stout retrorse prickles. Its leaves are imparipinnate, the leaflets rhombic-obovate, finely doubly serrate, smooth or slightly villous beneath. The flowers are white and borne in leafy racemes. The fruit is a short-cylindric or sub-globular etærio.

*Rubus allegheniensis* Porter (*R. nigrobaccus* Bailey), or the common Blackberry, is found in open woodlands from Nova Scotia to Ontario and southward to North Carolina. It is a shrub attaining a height of 1 to 2 m. Its older stems are reclining, purplish, with prominent stout straightish prickles. Its imparipinnate leaves have serrate leaflets that are appressed-villous above and velvety beneath. Its young branches and pedicels bear numerous glandular hairs. The flowers are white and borne in racemes, only the lower flowers being leafy bracted. The fruit is an etærio of numerous juicy, pleasantly flavored drupelets.

*Rubus cuneifolius* Pursh, or Sand Blackberry, is an ascending shrub growing in sandy or rocky soil from Connecticut to Florida west to Missouri and Louisiana. It grows to the height of 3 to 12 dm., has reclining stems bearing imparipinnate leaves with cuneate-obovate leaflets, serrate in upper half and white-tomentose beneath. Its inflorescences are 1 to 4 flowered.

**Production and Commerce.**—The bark is collected in spring or autumn by making a longitudinal incision in the side of the rhizome, when it can readily be removed in quills. It is then carefully dried. The commercial supplies are collected largely in Virginia, North Carolina, Illinois and Michigan.

**Description.**—In elongated, tough, flexible quills or bands, from 3 to 6 mm. in diameter, the bark up to 2 mm. in thickness; outer surface deep red brown or dark gray-brown or blackish-brown, somewhat scaly; inner surface yellow or pale brown, strongly and coarsely long straight-striate; fracture tough-fibrous; readily splitting; odor indistinct; taste strongly astringent and bitter.

**Constituents.**—*Tannin*; *gallic acid*; *villosin*, a glucoside; starch; calcium oxalate.

**Average Dose.**—1 Gm. (15 grains).

**Use.**—Astringent; in the form of fluidextract, syrup or decoction, for diarrhoea.

#### RUBI FRUCTUS (BLACKBERRIES)

**Synonyms.**—High Bush Blackberries; *Ger.* Brombeeren; *Fr.* Baies de ronce.

**Botanical Origin.**—*Rubus allegheniensis* Porter and *Rubus villosus* Aiton.

**Part Used.**—The fresh ripe fruit.

**Habitat and Plants.**—See *Rubus*.

**Description.**—Aggregate fruit, short cylindric or sub-globular, composed of numerous shining black drupelets attached to an esculent receptacle; pericarp externally smooth or with only a few hairs (*R. villosus*); mesocarp fleshy; juice purple-red; endocarps hard, black, surfaces deeply wrinkled; receptacle elongated, fleshy; odor slight; taste sweet, characteristic.

**Constituents.**—Malic acid, citric acid, tannin, volatile oil, pectin and an invert sugar.

**Uses.**—In addition to their extensive use as a food, blackberries have been employed as a flavoring agent and astringent in pharmaceutical preparations.

#### RUBUS IDÆUS (RASPBERRY)

**Synonyms.**—Red Raspberries, Rubi Idæi Fructus; *Ger.* Himbeeren; *Fr.* Framboises.

**Botanical Origin.**—Varieties of *Rubus idæus* L. and *Rubus idæus* L. var. *strigosus* (Michaux) Maximowicz [*R. strigosus* Michaux].

**Part Used.**—The dried ripe fruit.

**Habitat.**—Europe, Asia and North America.

**Plants.**—*Rubus idæus* or European Raspberry is a prickly stemmed shrub with upright light-colored stems having numerous stiff, straight or slightly hooked prickles, imparipinnate leaves with 3 to 5 oblong-ovate, cut-serrate leaflets which are whitish-hairy beneath, small white flowers with hairy calyx and arranged in racemes, and dark red aggregate fruits. The petioles, midribs, flowering shoots and pedicels exhibit scattered recurved prickles but are not glandular. *Rubus idæus* var. *strigosus* or Common Red Raspberry somewhat resembles *R. Idæus* but differs from it in being more slender stemmed, in

possessing glandular hairs on the inflorescence axis, and in having a less hairy calyx and a light red fruit.

**Description.**—Fruit aggregate, hemispherical to subglobular with a deep concavity at its base where it has been separated from the receptacle, consisting of about 20 small, rounded-polygonal, succulent drupelets; epicarp externally red with numerous non-glandular hairs up to  $640\mu$  long; mesocarp with parenchyma cells containing a red juice and rosette crystals of calcium oxalate up to  $35\mu$  in diameter; endocarp small, wrinkled and stony; odor characteristically aromatic; taste characteristic, sweet and acidulous.

**Allied Product.**—Black Raspberries, the dried ripe fruits of *Rubus occidentalis* Linné.

**Constituents.**—Citric acid, invert sugar, volatile oil, a trace of malic acid, and pectin.

#### SUCCUS RUBI IDÆI N.F. (RASPBERRY JUICE)

Raspberry Juice is the liquid expressed from the fresh ripe fruit of varieties of *Rubus idæus* L. or of *Rubus strigosus* Michx. [*Rubus idæus* var. *strigosus* (Michaux) Maxim.] (Fam. *Rosaceæ*).

**Standard of Assay.**—Not less than 1.5 per cent. of citric acid.

**Preparation.**—Ripe red raspberries are washed, drained and the juice expressed; 0.1 per cent. of benzoic acid is dissolved in the juice and the whole allowed to stand at room temperature until a small portion of the filtered juice produces a clear solution when mixed with one-half its volume of alcohol and this solution does not become cloudy within 30 minutes. The juice is then pressed out from the mixture and filtered. It is stored in tight containers, protected from sunlight and excessive heat.

**Description.**—A clear liquid with a characteristic, aromatic odor and a sour taste. Its color, when placed in a comparison tube to the depth of 1 cm., is moderate red to moderate reddish-orange.

**Use.**—Pleasant flavoring agent in pharmaceutical preparations.

**Preparations.**—Raspberry Syrup; Five Bromides Elixir (from Syr.), 4 cc.; Glycerinated Gentian Elixir (from Syr.), 8 cc.

#### POTENTILLA ANSERINA

**Synonyms.**—Silverweed Cinquefoil, Silver Weed, Wild Tansy, Silverfeather; Ger. Gänsefingerkraut.

**Botanical Origin.**—*Potentilla Anserina* L.

**Habitat.**—Along the margins of lakes and rivers of northern North America, Europe and Asia.

**Plant.**—A low perennial herb spreading by slender, many jointed runners, the nodes of which give origin to new plants. The leaves are petiolate and interruptedly-pinnate, radical, each with from 7 to 21 leaflets. The leaflets are dark green, nearly glabrous above, silky-tomentose beneath, oblong, and sharply pinnatifid-serrate. The inflorescence is solitary, consisting of a long

peduncle bearing a single yellow flower. The fruit is a smooth achene. The var. *concolor* Ser. possesses leaflets which are silky canescent on both surfaces.

**Constituents.**—Tannin, *glycosides*, tormentol, etc.

**Uses.**—In the form of an extract in essential dysmenorrhea and in diarrhea.

**Adulterants.**—(1) *Potentilla argentea* L., the leaves of which are cauline, palmately-compound, each with 5 oblanceolate or obovate leaflets, obtuse at the apex, cuneate at the base, lacinate, with revolute margins, green and glabrous above, silvery canescent beneath. The flowers are yellow and in terminal cymes.

(2) *Potentilla pacifica* Howell. This possesses petiolate, interruptedly-pinnate leaves, somewhat resembling those of *P. Anserina*, but the leaflets are larger, 11 to 35 in number, oblong, coarsely and sharply serrate. It occurs



FIG. 204.—*Potentilla Anserina*. Note the slender runners to right which serve as a means of spreading the plant. (Photograph by H. W. Youngken, Jr.)

along the margin of inlets and salt marshes of the north Pacific and Atlantic Oceans from Alaska to California and from Canada to Massachusetts.

#### BRAYERA (BRAYERA)

**Synonyms.**—Kousso, Cusso, Kusso; *Fr.* Cousso; *Ger.* Kosoblüthen.

**Botanical Origin.**—*Hagenia abyssinica* (Bruce) Gmelin.

**Part Used.**—The dried panicles of the pistillate flowers.

**Habitat.**—Abyssinia.

**Plant.**—An ornamental, monœcious tree attaining a height of from 6 to 12 m., occurring throughout the tableland of Abyssinia at an elevation of 3000 to 8000 feet above sea-level. The leaves are imparipinnate with 3 to 6 pairs of leaflets below the terminal one, which are sessile and serrate. Both staminate and pistillate flowers occur in broad panicles on the same tree. The fruit is an achene.

**Production and Commerce.**—The panicles of pistillate flowers are gathered by the natives while in full bloom and dried in the sun. Frequently panicles of staminate flowers are accidentally collected with them. The panicles are compressed into flattened bundles or rolls that are tied in spiral fashion with

stems of the same plant. Most of the drug is shipped to Bombay and Aden for reshipment. Small amounts have been imported into this country from Marseilles, France.

**Description.**—This drug formerly came into the market in rolls or flattened bundles of panicles, 25 to 60 cm. long, bound with flattened stems of *Cyperus articulatus* in spiral fashion. It now occurs in local markets, however, in broken



FIG. 205.—*Hagania abyssinica*—Flowering branch, and male and female flowers. Female flower above, male flower below. (Sayre.)

panicles, or more or less stripped from the larger portions of the panicles (loose brayera). Branches cylindrical, somewhat flattened, zigzag, furrowed and wrinkled longitudinally, light brown, hairy and glandular; internally exhibiting a circle of wedge-shaped bundles, the bast and wood fibers of which are yellow, and a large yellowish-brown pith; each node with a scar or branch and subtended by a sheathing bract; internodes generally up to 2 cm. in length; flowers subtended by two ovate, reddish, glandular-pubescent bracts; pedicel short; calyx top-shaped, pubescent beneath, subtended by 5 rigid, spreading, obovate,

purple-veined bractlets, persistent and becoming elongated in the fruit, alternating with and larger than the 5 somewhat shriveled, reflexed sepals; petals 5, caducous and usually absent in the drug; carpels 2, styles exserted stigmas broad and hairy with prominent papillæ; fruit an ovoid achene, surrounded by the remains of an adherent calyx. The staminate flowers are greenish-yellow with about 20 stamens; odor indistinct; taste bitter.

**Powdered Drug.**—Brown. Numerous simple, non-glandular hairs, up to about 1 mm. in length, with thick, lignified walls; glandular hairs with 1- to 3-celled stalks and a 1- to 2- to 4-celled head; calcium oxalate in rosette aggregates up to  $40\mu$  in diameter and occasionally in prisms about  $15\mu$  in length; fragments of tracheæ and thick-walled, lignified sclerenchyma fibers, the tracheæ being annular, spiral, porous and scalariform and up to  $54\mu$  in width, fragments of epidermis of the calyx and bracts with elliptical stomata up to  $30\mu$  in length; fragments of tissue from the fruit wall consisting of many elongated, porous, lignified cells; few nearly spherical pollen grains, up to  $40\mu$  in diameter, each possessing 3 pores.

**Constituents.**—*Kosotoxin* (chief active principle), protokosin, resin, volatile oil, tannin, calcium, oxalate, etc.

**Uses.**—*Brayera* is employed chiefly in the form of an infusion as a tæniifuge and anthelmintic.

**Average Dose.**—15 Gm. (240 grains).

**Adulterants.**—1. Stems over 3 mm. in diameter, which, when examined microscopically, exhibit simple non-glandular hairs ranging up to 4 or 5 mm. in length, tracheæ up to  $125\mu$  in breadth, and rosette aggregates of calcium oxalate up to  $75\mu$  in diameter.

2. Staminate inflorescences with flowers showing well-developed anthers and fertile pollen.

#### QUILLAJA N.F. (QUILLAJA)

**Synonyms.**—*Soaptree-bark*, Soapbark, Panama Wood, Cortex Quillaia, China or Murillo Bark; *Fr.* Ecorce de Quillaya; *Ger.* Seifenrinde.

**Botanical Origin.**—*Quillaja Saponaria* Molina.

**Part Used.**—The dried inner bark.

**Purity Rubric.**—Not more than 5 per cent. of adhering outer bark and not more than 1 per cent. of other foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—Chile and Peru. Cultivated in Southern California.

**Plant.**—A glabrous, evergreen, monœcious tree with thick bark containing saponin-glucosides, growing to the height of 18 m. and bearing alternate, ovate, simple, slightly serrate, coriaceous leaves and axillary clusters of white flowers. The fruit consists of 5 leathery follicles cohering at their base and with adherent calyx.

**Production and Commerce.**—The trees grow wild in Peru and Chile and are cultivated extensively in northern Hindostan. The bark is removed from the trunk and branches, deprived of most of its cork and dried. The commercial

supplies to the United States come chiefly from Valparaiso, Chile, and Hamburg, Germany. The bark which comes from Chile is the crude inner bark and arrives in burlap bundles. That which had been imported from Hamburg before the war was milled and arrived in two types. One type consisted of cut drug (square chips) and the other type was designated as siftings. The latter was usually very high in total ash (up to 20 per cent.), rich in calcium oxalate, and represented the refuse from chip manufacture. Both of the milled products were shipped in bags.

**Description.**—Soap Bark occurs in flat or partially quilled pieces of variable length, from 3 to 10 mm. in thickness, or in small chips; outer surface weak reddish-brown to weak yellowish-orange, often with small brownish patches of cork attached; inner surface weak yellowish-orange to yellowish-white, nearly smooth, crystalline, with occasional circular depressions, conical projections or transverse channels; fracture uneven, tough and strongly fibrous, exhibiting crystals; odor slight; taste acrid.

**Histology.**—Sections of Quillaja exhibit mostly phloem, separated into phloem patches by a number of medullary-rays. The bast fibers are thick-walled, strongly lignified, wavy, irregular, and arranged in groups in radial fashion as observed in transverse sections. Surrounding these groups are crystal fibers containing monoclinic prisms of calcium oxalate. The phloem parenchyma contains more or less spheroidal, simple, or 2- to 4-compound starch grains and numerous long styloids of calcium oxalate, some of which attain a length of  $200\mu$ .

**Powdered Drug.**—Very pale orange; very sternutatory and characterized chiefly by the numerous elongated prisms of calcium oxalate from 35 to  $200\mu$  in length, the crystal fibers containing calcium oxalate prisms, the peculiar strongly lignified bast fibers often associated with medullary rays, the stone cells with simple oblique pores, and the nearly spheroidal starch grains up to  $10\mu$ .

**Constituents.**—The toxic saponin glucosides, *quillajic acid* and *quillajapotoxin*; calcium oxalate, starch, etc.

**Uses.**—Irritant, nauseating expectorant and detergent. Employed as a constituent of some metal polishes, for washing fabrics for which soap is unsuitable, and as an ingredient in Coal Tar Solution, N.F.

**Preparations.**—Coal Tar Solution (Liquor Picis Carbonis), N.F., Quillaja Tincture (unof.).

#### AMYGDALA DULCIS (SWEET ALMOND)

**Synonyms.**—Jordan-, Valencia-, or Malaga Almonds, Greek Nuts; *Ger.* Süsse Mandeln; *Fr.* Amandes douces.

**Botanical Origin.**—*Prunus Amygdalus* Batsch var. *dulcis* (DC.) Koehne.

**Part Used.**—The dried ripe seed.

**Habitat.**—Probably Asia Minor and Persia.

**Plant.**—A small tree with purplish-brown bark and lanceolate, serrate, bright green leaves. Its flowers are pink, somewhat resembling peach blossoms.



Its fruit is a compressed ovate drupe having a downy epicarp, greenish leathery sarcocarp and yellowish endocarp which surround a yellowish- to reddish-brown, ovate or oblong, exalbuminous seed. When ripe the portion of the pericarp external to the endocarp splits into two halves and falls off the stone or "shell."

**Production and Commerce.**—The almond tree is cultivated in Persia, Turkestan, Mediterranean countries and California. The fruits are gathered when ripe, the hard outer portions of the pericarp removed and the seed with its enveloping papery endocarp collected. The commercial supplies come from Mogador, Morocco, and from Spain, Portugal, France, Sicily and Italy. The chief commercial varieties are Jordan and Valencia almonds. The former comes from Malaga and demands the highest price. Its seeds are long and narrow with a smooth, thin, buff seed coat. Valencia almonds come from Spain and possess broadly ovoid seeds with a thicker, rough, dark brown seed coat.

**Description.**—The seeds are entire, ovate or oblong-lanceolate, exalbuminous, up to 30 mm. in length, up to 17 mm. in breadth and 9 mm. or less in thickness; spermoderm thin, yellowish- to reddish-brown, coarsely longitudinally furrowed, easily removed on soaking the seed in water; embryo straight, whitish, consisting of two large plano-convex cotyledons, a short conical hypocotyl, and a short plumule at the pointed end of the seed; odor slight; taste bland and sweet. Upon bruising and triturating in water, a milk-white emulsion is produced which is devoid of the odor of benzaldehyde or hydrocyanic acid.

**Histology.**—Transverse sections of the almond seed show the following microscopic structures:

1. *Seed coat* consisting of (a) an *outer epidermis* of erect, rectangular stone cells with rounded angles, the lower half of each of which shows circular pore canals; (b) a *hypodermis* of brownish angular cells in 1 or 2 layers that are devoid of intercellular-air-spaces; (c) *spongy parenchyma* of more or less collapsed cells. Through this region the *raphe* courses with its spiral tracheæ. Some of the cells of the parenchyma possess crystals; (d) an *inner epidermis* of small cells with brown contents.

2. *Perisperm*, a hyaline layer.

3. *Endosperm*, consisting of a layer of small, cubical, aleurone cells with thick walls and a subjacent narrow layer of obliterated cells.

4. *Embryo* of 2 large plano-convex cotyledons and a small hypocotyl. Each cotyledon is covered by an epidermis beneath which is a broad zone of reserve parenchyma containing fixed oil globules and aleurone grains, the latter from  $3\mu$  to  $15\mu$  in diameter. Some of the aleurone grains contain a phytoalbumin, others globoids, still others, a rosette aggregate of calcium oxalate.

**Powdered Drug.**—Yellowish-white; numerous fragments of reserve parenchyma of endosperm containing aleurone grains and oil globules; fragments of the seed coat with more or less elliptical stone cells having thin, lignified, porous walls; numerous oil globules and aleurone grains, separated globoids and crystals; a few spiral tracheæ.

**Almond Meal** consists of almond cake, a by product in the manufacture of Almond Oil.

**Constituents.**—From 45 to 50 per cent. of *fixed oil*; from 20 to 25 per cent. of *protein*; asparagin, sucrose, gum, etc.

**Uses.**—Sweet almonds are used as a demulcent and nutritive. Almond meal is used as a detergent.

**Adulterants.**—The powdered drug has been frequently adulterated with or substituted by Peach Kernel Meal and Apricot Kernel Meal. Peach kernel

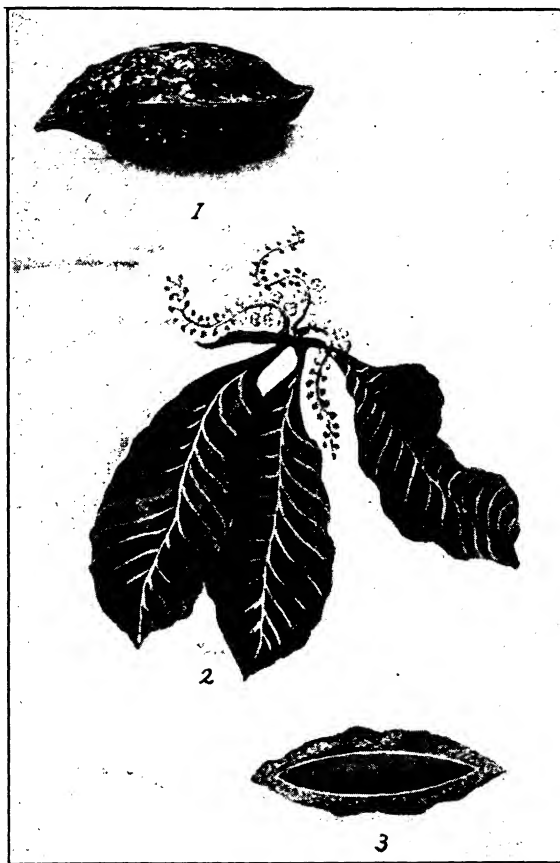


FIG. 206.—*Prunus Amygdalus dulcis*. (1) Fruit; (2) branch bearing leaves and flowers; (3) fruit cut across exposing seed.

meal is readily detected by the triangular stone cells of the outer epidermis of the seed coat which have rounded angles. Apricot kernel meal shows stone cells of rounded-triangular shape but smaller than those of peach kernels.

**Expressed Almond Oil** (*Oleum Amygdalæ Expressum*) U.S.P. or *Sweet Almond Oil* is a fixed oil obtained from the kernels of varieties of *Prunus Amygdalus* Batsch. It is a clear, pale straw colored or colorless oily liquid with a bland taste; sp. gr. 0.910 to 0.915 at 25°C. It is used in the preparation of Rose Water Ointment U.S.P., and as an emollient. The chief past adulterants of this oil have been the fixed oils from peach and apricot kernels, cottonseed oil, olive oil and lard oil.

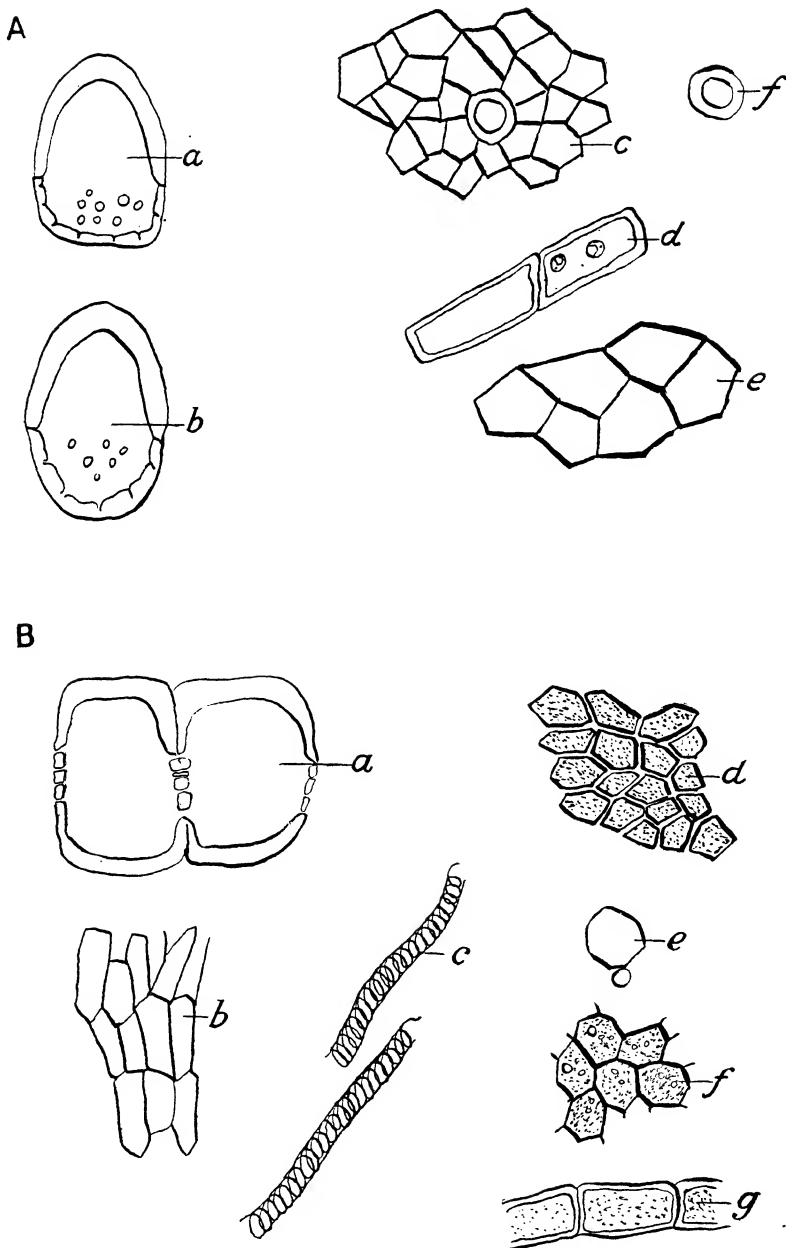


FIG. 207.—A, *Peach kernel meal*, a substitute for almond meal. Stony epidermal cells of seed coat, as seen in transverse view (a, b); surface view of hypodermis of seed coat (c); the somewhat rounded object near the center is a stone cell; enlarged view of portion of hypodermis (e); vertical view of stone cell (f); cotyledon cells (d). B, *Almond meal*. Transverse view of stone cells (epidermal cells) of seed coat (a); epidermal cells of cotyledon (b); spiral tracheæ (c); cells of a cotyledon containing aleurone (f); phytoglobulin and globoid of aleurone grain (e); lengthwise view of cells of cotyledon (g).

## AMYGDALA AMARA (BITTER ALMOND)

**Synonyms.**—*Ger.* Bittere Mandeln; *Fr.* Amandes amères.

**Botanical Origin.**—*Prunus Amygdalus* Batsch var. *amara* (DC.) Focke (*Amygdalus communis* Linné).

**Part Used.**—The dried ripe seed.

**Habitat.**—Probably Asia Minor and Persia.

**Plant.**—A tree resembling in habit the peach with grayish bark, shining lanceolate, serrate leaves, large, showy pink flowers and compressed ovate drupe fruits.

**Production and Commerce.**—The bitter almond is cultivated to a less extent than the sweet almond in Mediterranean countries. Our commercial supplies of the seed come from Sicily, Southern France and Morocco.

**Description.**—Closely resembling the sweet almond in form but averagely smaller and proportionately broader, with a bitter taste, and developing an odor of hydrocyanic acid when made into an aqueous emulsion or when bruised and moistened.

**Constituents.**—Fixed oil (about 45 per cent.), the glucoside *amygdalin*, the ferment *emulsin*, proteids, etc. In the presence of moisture, the ferment emulsin hydrolyzes the amygdalin to form *hydrocyanic acid*, *benzaldehyde* and glucose.

**Uses.**—Bitter almond is used in the production of Oil of Bitter Almond (volatile oil) and with seeds of other varieties of *Prunus Amygdalus* Batsch in the preparation of Expressed Almond Oil U.S.P. (fixed oil).

**Bitter Almond Oil** (*Oleum Amygdalæ Amaræ*) N.F. is a volatile oil obtained from the dried ripe kernels (deprived of fixed oil) of *Prunus Amygdalus* Batsch var. *amara* (DC.) Focke or from other kernels containing amygdalin, by maceration with water and subsequent distillation with steam. It yields not less than 95 per cent. of benzaldehyde ( $C_6H_5.CHO$ ) and not less than 2 per cent. and not more than 4 per cent. of hydrocyanic acid ( $HCN$ ). Do not dispense oil in which crystals have formed. The botanical source from which the oil has been obtained must be stated on the label. It is used as a cough sedative and to mask the taste of disagreeable oils; externally in dilute form for pruritus. Average dose, 0.03 cc. ( $\frac{1}{2}$  minim), well diluted. **Preparation.**—Bitter Almond Water, N.F.

## PERSIC OIL U.S.P. (OLEUM PERSICÆ)

**Synonyms.**—*Apricot Kernel Oil*, *Peach Kernel Oil*.

**Definition.**—A fixed oil expressed from the kernels of varieties of *Prunus Armeniaca* L. (Apricot Kernel Oil), or from the kernels of varieties of *Prunus Persica* Sieb. et Zucc. (Peach Kernel Oil) (Fam. *Rosaceæ*). The label must state whether the oil was derived from apricot kernels or peach kernels.

**Habitat.**—Asia. The peach tree is a native of China. The apricot tree, probably from Siberia to China.

**Description.**—A clear, pale straw-colored or colorless, oily liquid, almost odorless and with a bland taste; sp. gr. 0.910 to 0.918 at 25° C.

**Uses.**—Emollient; as a war emergency substitute for expressed oil of almond in cold cream and other preparations whose formulas contain expressed oil of almond.

#### CYDONIUM (QUINCE)

**Synonyms.**—Quince Seed, Semen Cydoniæ; *Ger.* Quittensamen; *Fr.* Semences de Coing.

**Botanical Origin.**—*Cydonia oblonga* Miller [*Cydonia vulgaris* Pers.; *Pyrus Cydonia* L].

**Part Used.**—The dried ripe seed.

**Habitat.**—Asia. Cultivated in the United States and Europe.

**Plant.**—A shrub or small tree with slender branches, oval or oblong entire leaves, villous hairy on their under surfaces, white or light pink flowers and large, yellow, globular to pyriform, edible, pome fruits, the latter villous-hairy before maturity.

**Production and Commerce.**—The fruits are gathered in autumn when mature, crushed, the seeds removed and dried. During 1945, 106,068 pounds of quince seed were imported into this country from Iran, Iraq, Portugal and the Union of S. Africa. In 1947, 158,007 pounds arrived from Iran.

**Description.**—The drug occurs in single seeds and agglutinated masses of seeds up to 10 mm. long and 6 mm. broad, each seed being ovoid or oblong, triangularly compressed; outer surface reddish brown and covered partially or completely with a whitish hardened mucilage which causes the seeds to adhere; internally showing a whitish embryo of 2 fleshy cotyledons and a hypocotyl; with water the seed coat swells up and forms a mucilaginous mass; taste mucilaginous and characteristic.

**Constituents.**—*Mucilage* (22 per cent.); the glucoside amygdalin, the enzyme emulsin, fixed oil, protein, tannin, etc.

**Uses.**—The seeds are made into a mucilage by maceration with water (2:100) which is used as a soothing vehicle in skin lotions and other cosmetics.

#### PRUNUM (PRUNE)

**Synonyms.**—Damson Plum; *Fr.* Pruneau noir; *Ger.* Zwetsche, Pflaume.

**Botanical Origin.**—*Prunus domestica* Linné.

**Part Used.**—The partially dried ripe fruit.

**Habitat.**—Probably the Caucasus region of Southwestern Asia.

**Plant.**—A small tree with large, thick, ovate or obovate leaves having coarsely serrate margin, large white flowers, and a soft-fleshed fruit, at maturity, with a deeply pitted stone.

**Production and Commerce.**—The trees are cultivated for their fruit in California, France, Germany, and Asia Minor. The fruits are gathered when ripe, cleaned by passing them through hot water or a dilute solution of lye to kill insect eggs and larvæ, rinsed in water, partially dried in the sun or by dehydration methods, allowed to sweat for 2 weeks, then glossed by heating in steam, fruit juice or glycerin, and graded as to weight and size. The chief source of

the prunes used in this country is California which furnishes about 60 per cent. Oregon, Washington and Idaho contribute about 30 per cent. California prunes are usually sun dried or dehydrated.

**Description.**—The fruits occur as ellipsoidal or oblong, brownish-black, somewhat compressed drupes more or less shriveled externally; the sarcocarp is sweet and acidulous; the putamen or stone is brown, flattened, ellipsoidal, smooth, irregularly ridged; the seed is almond-shaped and possesses a taste resembling that of bitter almond.

**Constituents.**—Sugar, tartaric, malic and other organic acids, etc.

**Uses.**—Laxative and nutrient. When used in the preparation of confection of senna and for other pharmaceutical purposes it should contain from 30 to 35 per cent. of its natural moisture.

### LEGUMINOSÆ (PEA AND BEAN FAMILY)

Herbs, shrubs or trees of all regions, with tubercled roots, the tubercles containing bacteria (*Pseudomonas radicicola*). Stem usually erect, rarely creeping (*Trifolium repens*). Leaves alternate, compound—rarely simple—stipulate, sometimes tendrilliform (Pea, etc.), or reduced to phylloid petioles (*Acacia* spp.). Inflorescence a raceme (*Cytisus*, etc.) or spike (*Glycyrrhiza*), at times condensed almost to a head or capitulum (Spp. of clover, *Mimosa*, etc.). Flowers pentamerous (rarely 4), regular, (sub. fam. *Mimosaceæ*), to irregular (sub. fam. *Cæsalpinaceæ*, *Papilionaceæ*). Sepals 5 united, green; petals 5 (rarely 4) variously related, in *Papilionaceæ* one superior, external, posterior—standard or vexillum, 2 lateral form wings or alæ, 2 inferior, internal and anterior, slightly adherent, form keel. Stamens 10 to 4, free, or in *Papilionaceæ* united by filaments into a monadelphous (10) or a diadelphous (9 to 1) tube, inserted perigynously. Pistil monocarpellary, ovary with sutural placentation, style simple. Fruit a legume or loment. Seeds exalbuminous.

To this family belong important forage plants like clovers, alfalfa, vetches, cowpeas, economic food-yielding plants such as peas, beans and lentils, the insecticide yielding plants such as derris, cube root and tephrosia, and timber trees as Kentucky-coffee, honey locust, black locust, etc. The histological characters vary for the most part in the different sub-families and genera. Those common to all the Leguminosæ, according to Solereder, are simple perforations in the tracheæ and simple-pitted wood prosenchyma.

### GLYCYRRHIZA U.S.P. (GLYCYRRHIZA)

**Synonyms.**—*Licorice Root*, Liquorice Root, Sweet Wood, *Ger.* Lakritzenholz, Stüssholz; *Fr.* Régliste, Bois doux.

**History.**—Licorice has been in use in the form of the crude drug, medicinal pastes and aqueous extract since remote times. It is mentioned by Theophrastus and Dioscorides and by the Roman writers Marcellus and Pliny as *Radix dulcis* and is recorded as being common in Europe during the Middle Ages. It was cultivated in Italy as early as the thirteenth century and in England during the sixteenth century.

**Botanical Origin.**—*Glycyrrhiza glabra* Linné var. *typica* Regel et Herder and *Glycyrrhiza glabra* Linné var. *glandulifera* Waldstein et Kitaibel or other varieties of *Glycyrrhiza glabra* Linné yielding a yellow and sweet wood.

**Parts Used.**—The dried rhizome and roots.

**Purity Rubric.**—It yields not more than 2.5 per cent. of acid-insoluble ash.

**Habitat.**—Southern Europe, Northern Africa and Western and Central Asia.

**Plants.**—*Glycyrrhiza glabra typica* which yields the commercial variety known as Spanish Licorice, is a perennial herb cultivated on a large scale in southern Europe. Its underground portion consists of a spreading slender rhizome bearing fibrous roots. Its aerial portion consists of a branched stem attaining a height of 1 to 1.5 m. bearing alternate imparipinnate leaves with petioled, pale green, ovate, entire leaflets and axillary spikes of violet-colored papilionaceous flowers. The fruit is a compressed legume containing kidney-shaped seeds.

*Glycyrrhiza glabra glandulifera*, the source of Russian Licorice, somewhat resembles the former species, differing from it mainly by its underground portion consisting of a large rhizome which gives off long, thick, fusiform roots and by its aerial portion being glandular-hairy.

**Production and Commerce.**—The plants grow wild and are cultivated in southern Europe, Russia, Syria and Iraq. About 90 per cent. of the licorice entering American commerce is collected from wild plants and most of it comes from Turkey, Spain, Syria, Iraq, Afghanistan and Russia. The commercial supplies of the root come from Barcelona, Alicante and Seville, Spain, from Portugal, from Malta, from Iraq and Russia, from Leghorn, Italy, from Smyrna, Alexandretta and Haifa, Syria, Afghanistan, China, and Turkey, and are generally named after the country in which they are grown. Russian licorice root (peeled and unpeeled) is imported directly from the Soviet Union. Persian licorice is exported from Bussorah, Iraq. Licorice root is shipped in covered and uncovered bales. The cut root is shipped in bags. The chief causes of inferiority are poorly dried and moldy roots. Licorice extract occurs chiefly in four commercial varieties, viz.: Italian, Spanish, French and Turkish. The Spanish is made in large quantities at Seville, Spain. The Italian is made extensively at Catairra, Italy. Licorice extract is also made in large quantities in Philadelphia, Pa. Stick licorice (extract) comes packed in bay leaves.

A very good Licorice Root is yielded by *Glycyrrhiza malensis*. This drug is imported from China in limited amounts.

Spain is the largest producer of cultivated licorice.

There are four general types of Spanish root now produced. These are the Toledo, Seville, Zaragoza and Alicante. The Toledo is the best root and is usually a cent and a half higher than the other Spanish grades. Next comes the Seville root which is from one-half to one cent higher than either the Zaragoza or Alicante, which are regarded as being of about the same quality. Spanish root is harvested from the same ground every third year, and in harvesting a furrow of approximately four feet in width is turned with the plow and the roots are then collected and transferred to large drying sheds with open ends



FIG. 208.—*Glycyrrhiza glabra*. 1. Upper part of flowering plant. 2. Flower. 3. Calyx. 4. Petals. 5. Stamens. 6. Pistil. 7. Legume. 8, 9. Seeds. 10. Sections of same. 11. Portion of root and base of stem. (After Bentley and Trimen.)



toward the prevailing wind. The roots are spread on the floor of this drying shed to a depth of about six feet and are frequently worked over with large forks until they are so dry that they break with a snap. The roots are then ready for baling. This drying process takes from four to six months. In the drying the root shrivels and any adhering dirt falls off in the forking. All other grades or types of root are dried in very much the same manner. Grecian licorice requires usually from six to eight months before it is sufficiently dried for shipping. During 1947, 55,922,459 lbs. of Licorice Root were imported into this country.

**Cultivation.**—Warm regions are best suited for the culture of licorice. The soil should be deep, sandy and fertile. The plants are propagated from cuttings

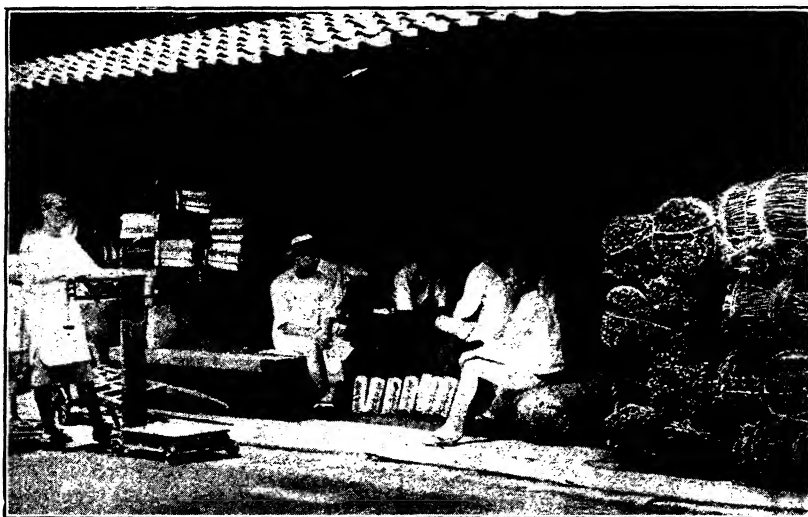


FIG. 209.—Wholesale dealer in licorice root. On the right of the illustration are piled up the bales of licorice root as imported from China. These roots are cut into a certain length and packed in paper bags as seen on the left hand side of the picture. (After a photograph by Parke, Davis and Company.)

of the younger parts of the rhizomes, from suckers, by crown division or from seed. The plants are set out in the spring about 2 ft. apart in rows spaced for cultivation. They develop rhizomes of suitable size for marketing in 3 or 4 years. These are harvested in late summer by turning the soil over to a depth of 3 or 4 ft. with a plough and pulling them out by hand. They should be spread out on a drying floor in a well ventilated shed and stirred frequently, placed on a shaker to remove adherent soil and dried by artificial heat, passed through trays with wire mesh bottoms in which they are placed, until they break with a snap.

**Description.**—Spanish (or Italian, Turkish, Levant) Licorice usually occurs on the market in bundles of nearly cylindrical segments of the rhizomes and roots bound with wire, but occasionally, as small pieces, known as "cut licorice," rarely in the entire form; segments from 14 to 20 cm. or more in length and from

5 to 20 mm. in diameter; externally yellowish-brown or dark-brown, longitudinally wrinkled with patches of cork adhering, the upper portion of the rhizome showing a knotty crown, the thinner rhizomes showing alternate buds, the roots small and emanating from the rhizome near the buds; fracture coarsely fibrous; internally yellow, bark and wood radiate, the rhizome having a small pith; odor distinct; taste sweetish and slightly acrid.

**Russian Licorice** usually occurs as broken or longitudinally cut segments of peeled roots, sometimes as unpeeled roots; segments 15 to 30 cm. in length and from 1 to 5 cm. in diameter; when deprived of cork, externally pale yellow, otherwise brownish-red; fracture coarsely fibrous; internally lemon-yellow, cortex and wood radially cleft and radiate; odor distinct; taste sweetish.

**Persian Licorice** occurs in large thick segments which have a strikingly similar appearance to the unpeeled Russian variety. It is yielded by *Glycyrrhiza glabra* Linné var. *β. violacea* Boissier.

**Histology.**—*Transverse sections* of the older parts of the rhizome of Spanish Licorice exhibit the following microscopical structure:

1. *Cork*, of many layers of cork cells with reddish-brown contents.
2. *Cork cambium*, of somewhat collapsed meristematic cells.
3. *Secondary cortex*, of one or more layers of collenchymatic cells some containing monoclinic prisms of calcium oxalate.
4. *Primary cortex*, a very narrow zone of cortical parenchyma, some of the cells containing ellipsoidal or oval starch grains, others monoclinic prisms of calcium oxalate.
5. *Phloem*, a broad zone of elongated, radially arranged phloem patches separated from one another by prominent medullary rays of the phloem. Each phloem patch consists of a matrix of soft bast in which are found groups of thick walled bast fibers, adhering to which are cells of crystal fibers containing monoclinic prisms of calcium oxalate.
6. *Cambium*, a zone of several layers of meristematic cells.
7. *Xylem*, a broad zone of numerous, elongated, radially arranged xylem patches, separated from each other by medullary rays which are continuous through the cambium, with those of the phloem. Each xylem patch consists of a matrix of starch and crystal containing wood parenchyma imbedded in which are broad tracheae with yellowish walls and compact groups of thick, yellow-walled wood fibers that are partially surrounded by the cells of crystal fibers containing monoclinic prisms of calcium oxalate. Each trachea is surrounded by a ring of yellow tracheids and wood fibers.
8. *Pith*, a central zone of parenchyma, containing starch and monoclinic prisms of calcium oxalate of similar character to those found in the cortex.

*Longitudinal sections*, cleared by warming in chloral solution, show bands of bast fibers in the phloem and of wood fibers in the xylem, their ends tapered and spliced over each other. Adhering to the outside of a group of these fibers will be noted long rows of superimposed cells, each containing a monoclinic prism of calcium oxalate. These are the crystal fibers. The tracheae will be

found to be rather short with thick yellow walls, the broader usually marked by compactly arranged oval-shaped bordered pores, the narrower with ovate pits or reticulations. The medullary rays, as determined in tangential sections, are 1 to 8 cells wide.

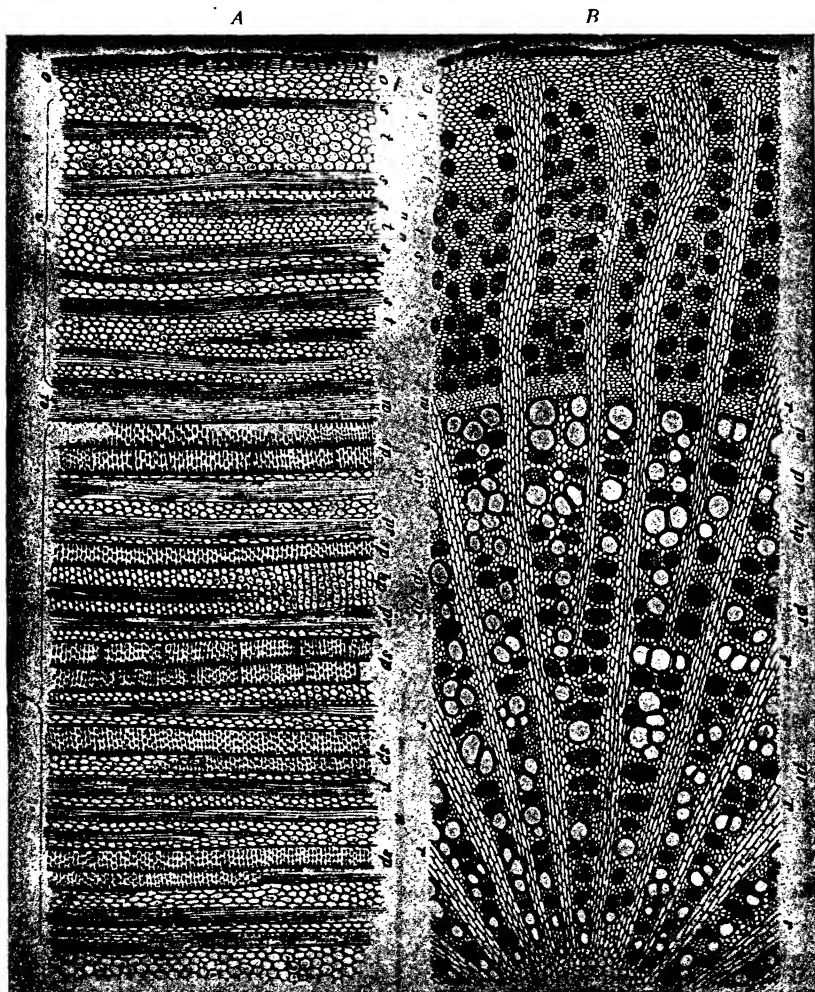


FIG. 210.—Glycyrrhiza. *B*, Representative portion of a transverse section of *G. glabra* rhizome, deprived of starch by maceration in weak alkali,  $\times 65$ . *A*, Radial-longitudinal section of same,  $\times 65$ . *a*, bark; *b*, wood; *c*, pith; *e*, cork; *o*, cortex; *r*, medullary rays; *s*, bast fibers; *t*, soft bast; *n*, crystal fibers; *w*, cambium; *hp*, wood parenchyma; *pr*, wood fibers; *sp*, tracheæ. (After Berg.)

**Powdered Drug.**—Brownish-yellow (Spanish or Persian Licorice) or pale yellow (Peeled Russian Licorice); starch grains numerous, mostly single, oval or elliptical, with an elongated ovate or linear or crescentic cleft; the majority varying from 3 to  $12\mu$  in length, but attaining in some instances a length of  $20\mu$ ; numerous fragments of bast and wood fibers, adhering to which are crystal

fibers, the cells of which contain monoclinic prisms of calcium oxalate up to  $30\mu$  in length; fragments of parenchyma with clear walls, and frequently with monoclinic prisms of calcium oxalate or starch; fragments of yellow tracheæ up to  $200\mu$  in diameter with bordered pores and few reticulate tracheæ often

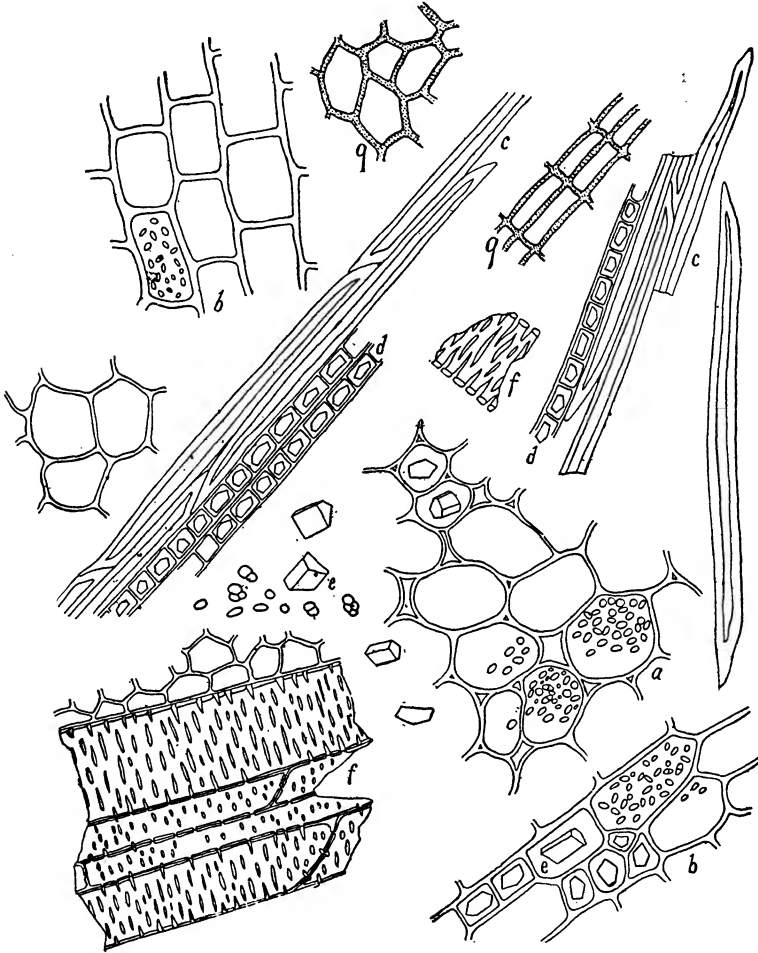


FIG. 211.—Powdered Glycyrrhiza. (a) Parenchyma; (b) parenchyma with crystals and starch; (c) bast; (d) crystal bearing fibers; (e) crystals; (f) ducts and tracheids; (g) cork tissue. (Schneider.)

with accompanying tracheids; fragments of reddish-brown cork tissue in unpeeled drug.

**Constituents.**—5 to 8 per cent. of *glycyrrhizin*, an intensely sweet, water-soluble principle consisting of the potassium and calcium salts of glycyrrhizic acid ( $C_{44}H_{64}O_{19}$ ); *glycyramarin* (a bitter principle) occurring mostly in the bark; mannite, yellow-coloring matter, volatile oil, resin, starch, sucrose, glucose, calcium oxalate, etc.

**Uses.**—Demulcent, expectorant and flavoring agent. The powdered root is extensively employed as a pill excipient and the fluidextract to disguise the taste of nauseous preparations.

Most of the licorice imported is used by the tobacco manufacturers in the flavoring of tobacco. The candy industry consumes a fair quantity. Small quantities of licorice paste are employed in the manufacture of shoe polish.

**Average Dose.**—2 Gm. (30 grains).

**Preparations.**—U.S.P.—Glycyrrhiza Extract (*Licorice*) which may be prepared from the rhizomes and roots of any species of *Glycyrrhiza*; Pure Glycyrrhiza Extract; Glycyrrhiza Fluidextract, 2 cc. (30 minims); Glycyrrhiza Syrup. N.F.—Glycyrrhiza Elixir (from Fldext.); Compound Opium and Glycyrrhiza Mixture (from Fldext.), 4 cc.; Compound Senna Powder, 4 Gm.; Mercury Mass, 0.2 Gm. (3 grains).

**Allied Drugs.**—American or Wild Licorice is the root of *Glycyrrhiza lepidota* (Nutt.) Pursh, which grows wild in the western part of the United States and lower Canada. It contains up to 6 per cent. of glycyrrhizin.

Manchurian Licorice is the root of *G. uralensis* Fischer indigenous to Siberia. It resembles unpeeled Russian licorice, differing chiefly from the latter by its wavy medullary-rays, softer wood with lacunæ, more readily separable cork and less sweet taste.

#### COPAIBA N.F. (COPAIBA)

**Synonyms.**—*Copaiba Balsam*, Copaiva, Balsam of Copaiva; *Fr.* Copahu; *Ger.* Copaiva balsam.

**History.**—The trees yielding Copaiba are first mentioned under the name of "Copei" in a report by Petrus Martys to Pope Leo X published by Herr in Strassburg in 1534. The drug is mentioned in 1625 under the name of "*Cupayba*" by a Portuguese monk who wrote on Brazil and its products. One of the trees yielding it was first described and illustrated by Piso and Marcgrav in 1648. It was listed in the London Pharmacopœia of 1677 and has been official in every edition of the U.S.P. from 1820 until 1940 when it was admitted to the National Formulary.

**Botanical Origin.**—South American species of *Copaifera* L. (*Copaiba* Miller): (Sub-fam. *Caesalpinaceæ*).

**Part Used.**—An oleoresin.

**Habitat.**—Tropical regions of South America, notably Brazil, Venezuela, Guiana and Colombia.

**Plants.**—Trees considerably branched, the branches having smooth bark and bearing alternate paripinnate leaves, each with 6 to 10 entire, ovate, coriaceous, pellucid-punctate leaflets. The flowers are small and white, each consisting of a receptacle bearing 5 sepals, 10 stamens and a monocarpellary pistil. The fruit is a one-seeded legume.

**Production and Commerce.**—The main species yielding Copaiba are *Copaifera reticulata*, *C. guianensis* and *C. Langsdorffii*, native to Brazil, which grow along the Amazon and its tributaries, and *C. Jacquini* native to Vene-

zuela, Guiana and Colombia. The drug is thought to represent a morbid product of the cell walls of the wood parenchyma which accumulates in cavities within the trunk of the tree. These cavities enlarge and join with each other to form huge reservoirs that hold frequently several gallons of oleoresin. The oleoresin is obtained commercially by drilling two holes into the wood of the trunk of the tree one about 10 to 20 ft. above ground and another 2 to 3 ft. above ground. A bamboo tube, carrying a stopcock, is thrust into the lower hole and the Copaiba drawn off into empty gasoline cans. In Brazil the chief producing regions are in the States of Pará and Amazonas, the two principal exporting centers being Manáos and Belém-Pará. The crude products brought to these centers consist of lots varying in color, origin and solubility. From these the exporters remove water, bark and other foreign matter and assort the lots according to solubility and color. Copaiba is imported from Pará, Brazil, Maracaibo, Venezuela and from El Salvador. 77,106 lbs. entered the U.S.A. in 1947.

**Description.**—A more or less viscid liquid of pale yellow to yellowish brown color, either without fluorescence or with only a slight greenish fluorescence and having a characteristic aromatic odor and persistent, bitter and acrid taste. It is insoluble in water, partly soluble in 95 per cent. alcohol, almost completely soluble in dehydrated alcohol, completely soluble in chloroform and ether, in fixed and volatile oils. When heated on a water bath, no odor of turpentine is evolved. Its specific gravity is between 0.915 and 0.995 at 25°C.

**Adulterants.**—(1) Gurjun Balsam is yielded by several trees of the genus *Dipterocarpus* (Fam. *Dipterocarpaceæ*) native to India, Siam and other countries of Southern Asia. Like Copaiba it is a thick and viscid liquid with an odor resembling it but weaker, and a bitter aromatic taste; but it lacks the persistent acidity of Copaiba. Its presence as an admixture may be ascertained by the following test: Mix 1 drop of nitric acid and 3 cc. of glacial acetic acid in a test tube and carefully add 4 drops of oil separated from the Copaiba sample by distillation with steam; if Gurjun balsam is present, a reddish zone appears and the liquid becomes reddish or purplish after being shaken.

(2) Paraffin Oils. These may be detected by shaking 5 cc. of the sample with 15 cc. of alcohol in a 50-cc. test tube, boiling the mixture for one minute, cooling and allowing it to stand for one hour. If oil separates, the presence of paraffin oils is indicated.

(3) Oil of Turpentine. Detected by its characteristic odor, upon heating the sample in a shallow dish on a water bath.

(4) African Copaiba or Balsam of Illurine is obtained from an unidentified tree (probably *Hardwickia Mannii*, Fam. *Leguminosæ*) growing in the Niger region, near the western coast of Africa. It is dark yellow with a peppery odor and dextro-rotatory, forming a crystalline deposit of illurinic acid on standing. During 1945, 22,460 lbs. of African Copaiba were imported from Nigeria.

(5) Castor Oil.

(6) Olive Oil.

(7) Kerosene.

**Constituents.**—From 40 to 90 per cent. of a lævo-rotatory *volatile oil* (highest in the Pará variety) containing  $\alpha$  and  $\beta$  *caryophyllene*, *cadinene*, other sesquiterpenes and a sesquiterpene alcohol; 35 to 40 per cent. of resin acids, copaivic acid, bitter principle, etc.

**Uses.**—Copaiba is employed as a stimulant and disinfectant in chronic inflammations of the genitourinary tract such as chronic cystitis, and as a stimulating expectorant in bronchitis. It is also used in the manufacture of lacquer, varnishes and tracing paper, and in the scenting of soaps and cosmetics, where it serves as a fixative. Oil of Copaiba is used as a diluent in perfume compounds and as a mellowing and blending agent to conceal harsh notes in synthetic aromatics.

**Average Dose.**—1 cc. (15 minims).

**Preparation.**—Copaiba Mixture (Lafayette Mixture) N.F., 8 cc. (2 fl. dr.).

#### PERUVIAN BALSAM U.S.P. (BALSAMUM PERUVIANUM)

**Synonyms.**—Balsam of Peru, *Peru Balsam*, Indian Balsam, Black Balsam; *Ger.* Perubalsam; *Fr.* Baume de Sansonate.

**Botanical Origin.**—*Myroxylon Pereiræ* (Royle) Klotzsch (*Toluifera Pereiræ* (Royle) Baillon).

**Part Used.**—A balsam.

**Habitat.**—Central America. Naturalized in Ceylon and Florida.

**Plant.**—An evergreen tree branching 2 to 3 m. from the ground, attaining a height of 25 m., and found growing in dense forests near the coast of San Salvador. It bears alternate, imparipinnate, hairy leaves each with 9–13 ovate and emarginate leaflets. Its flowers are white, each with a cup-shaped calyx and arranged in loose racemes. Its fruit is a 1-seeded, yellowish-brown legume, narrowed towards the stalk end.

**Production and Commerce.**—The balsam is a pathological product formed by mechanical injury to the trees. During November and December or after the rainy season, the native Indians beat the stems of the balsam trees with a blunt instrument on 4 sides, leaving alternate similar areas of bark unbruised so as not to kill the trees. The injured bark soon cracks and is readily pulled off in long strips. A small quantity of balsam exudes from this bark but insufficient to be worthwhile collecting it. About 5 days after the beating of the stems, torches are applied to the bruised bark and the latter is charred. About a week later the bark drops off or is removed and the balsam freely exudes from the stem. It is collected by covering the denuded wood with rags, which, after becoming soaked with the exudation, are thrown into water and boiled. The balsam separates and sinks to the bottom. The water is decanted and the balsam poured into tin containers. The commercial supplies of this drug are imported into the United States from San Julian, San Salvador, from Nicaragua and Guatemala. During 1947, 49,711 lbs. arrived.

**Description.**—A thick, viscid, dark-brown liquid; free from stringiness or stickiness; transparent and reddish-brown in thin layers; odor aromatic, vanilla-like; taste bitter, acrid, with a persistent after taste, producing a burning

sensation when swallowed. It is soluble in alcohol, glacial acetic acid and chloroform with not more than a slight opalescence. Its specific gravity is 1.150 to 1.170 at 25°C.

**Adulterants.**—(1) Turpentine. This may be detected by warming 1 Gm. of the suspected sample with 5 cc. of purified petroleum benzin on a water bath for about 10 minutes, and evaporating 2 cc. of this benzin solution, which will give off vapor having the characteristic odor of turpentine, if same be present.

(2) Colophony. If the residue left after following the method indicated above be treated with several drops of nitric acid, a greenish or bluish color would indicate the presence of rosin.

(3) Fixed oils. The presence of fixed oils as added adulterants may be determined by shaking 1 Gm. of the suspected material with a solution of 3 Gms. of chloral hydrate and 2 cc. of distilled water. Cloudiness would indicate fixed oil admixture.

**Constituents.**—About 63 per cent. of *cinnamein* (a volatile oil containing *benzyl benzoate*, *benzyl cinnamate*, etc.), resin esters, *cinnamic acid*, peruvial, dihydro-cinnamic acid, vanillin, etc. The more cinnamein or oil of Peru balsam, the higher the value of the drug.

**Uses.**—Balsam of Peru is employed externally in the form of an ointment as a parasiticide in scabies, ring-worm and pediculosis, also in the form of a solution for sluggish granulations. It is used internally as a stimulating expectorant. The perfume industry employs it in preparing heavy odors of the oriental type.

**Preparation.**—Compound Acetylsalicylic Acid Paste (Dental Anodyne Paste), N.F.

#### TOLU BALSAM U.S.P. (BALSAMUM TOLUTANUM)

**Synonyms.**—*Tolu*, Balsam of Tolu; *Fr.* Baume de Tolu; *Ger.* Tolubalsam.

**Botanical Origin.**—*Myroxylon Balsamum* (L.) Harms (*Toluifera Balsamum* L.).

**Part Used.**—A balsam.

**Habitat.**—South America (Colombia, Venezuela, New Granada).

**Plant.**—A tall tree with spreading crown somewhat like *Myroxylon Pereira*, differing from it mainly by its habit of branching about 14–16 m. above ground, in having leaves with 7–11 leaflets and these with acuminate summits, and in bearing dense racemes of flowers, each with a tubular calyx.

**Production and Commerce.**—Tolu Balsam is believed to be formed in the trunk of the tree as the result of injuries. Most of the drug is produced in the province of Tolu along the Magdalena and Cauca rivers in Colombia. It is obtained by two methods. One of these consists of making V-shaped incisions in the trunk, extending into the wood. As many as 20 to 30 of these are made in one tree. Below each V-shaped cut, the bark and wood are hollowed out and a calabash is fixed by the collector to catch the flow of balsam. From time to time the balsam collector goes round the trees and empties the exudate from the calabashes into bags of hide which are slung over the back of a donkey. In these bags the balsam is shipped to Cartagena and Barranquilla where it is



transferred to cylindrical tin cans containing from 10 to 25 pounds and exported.

The second method consists of lacerating the bark of the trunk by making deep incisions with machetes and then caulking burlap into the wounds to absorb the balsam as it exudes. As the burlap becomes saturated with the balsam, it is removed, boiled in water, pressed, and the balsam purified and packed in tin cans. It is exported mainly from Barranquilla, Colombia. During 1947, 136,557 lbs. of Tolu were imported into this country.

**Description.**—A yellowish-brown or brown plastic solid, becoming brittle when old, dried, or exposed to cold; transparent in thin layers; nearly insoluble in water, soluble in alcohol, chloroform and ether; odor vanilla-like; taste mildly aromatic.

**Standards.**—*Acid value*, not less than 112 and not more than 168. *Saponification value*, not less than 154 and not more than 220.

**Adulterants.**—Rosin, Rosin Oil and Copaiba. These may be detected by shaking 2 Gm. of the sample with 20 cc. of carbon disulfide, allowing to stand a half hour, filtering the liquid and evaporating the filtrate to dryness. The residue, thus obtained, is triturated with 10 cc. of petroleum benzin and filtered into a dry test tube. To the filtrate add 5 cc. of cooled 50 per cent. sulfuric acid solution, shake vigorously, allow the mixture to settle and add acetic anhydride drop by drop. If either rosin, rosin oil or copaiba are present, a red, violet or purple band is formed.

**Constituents.**—An aromatic *volatile oil* (about 7 per cent), containing *benzyl benzoate* and *benzyl cinnamate*; resin (75 to 80 per cent) consisting chiefly of a cinnamic acid ester of tolueresinotannol and a small percentage of a benzoic ester of tolueresinotannol; *cinnamic acid*, *benzoic acid*, an alcohol known as *toluresino-tannol*, vanillin, etc.

**Uses.**—Stimulating expectorant, antiseptic and flavoring agent in cough syrups. Tolu is also used in the manufacture of chewing gum, cosmetics and perfumery.

**Preparations.**—In *U.S.P.*: Tolu Balsam Tincture, 2 cc.; Tolu Balsam Syrup (from Tr.), 10 cc., Compound Benzoin Tincture, 2 cc.

#### GALEGA (GALEGA)

**Synonyms.**—Goat's Rue, European Goat's Rue; *Ger.* Pestilenzkraut, Geisraute; *Fr.* Rue de Chèvre.

**Botanical Origin.**—*Galega officinalis* Linné.

**Part Used.**—The dried flowering herb.

**Habitat.**—Southern Europe and W. Asia. Naturalized in the United States.

**Plant.**—A hardy perennial herb growing to the height of 2 to 3 feet and possessing odd-pinnate leaves and papilionaceous flowers which, while purplish-blue in the pure species, vary from white, lilac to rose colored in the several varieties.

**Production and Commerce.**—Galega is gathered in Italy and France when the plants are in flower, carefully dried and packed in burlap bags and bundles. The commercial supplies are imported chiefly from Leghorn and Marseilles.

**Description.**—The drug generally occurs as cut and broken portions of the flowering tops. Stem smooth and branched; leaves imparipinnate with six to eight pairs of leaflets; stipules lanceolate, sagittate on one side; leaflets bright green, smooth or slightly hairy, short petioled, lanceolate or ovate lanceolate, obtuse, slightly mucronate, from 2 to 5 cm. in length and from 2 to 6 mm. in breadth; flowers small, white to purplish-blue, papilionaceous, in axillary racemes; fruit a slender legume containing 4 to 6 brownish black seeds; odor indistinct; taste mucilaginous, slightly bitter and astringent, the saliva being colored a yellowish-green.

**Powdered Drug.**—Light green to yellowish-green. The chief diagnostic elements are numerous curved or slightly undulate, thick-walled, non-glandular hairs, crystal fibers containing monoclinic prisms of calcium oxalate up to  $25\mu$  in length and smooth, spheroidal pollen grains up to  $20\mu$  in diameter.

**Constituents.**—An alkaloid called *galegine* (Tanret) which is a guanidine derivative possessing the property of reducing blood sugar; tannin, bitter principle, etc.

**Uses.**—Galega has been employed as a galactagogue, diuretic and stimulant.

**Average Dose.**—4 Gm. (60 grains). **Preparation.**—Fluidextract, 4 cc.

#### TRIFOLIUM (TRIFOLIUM)

**Synonyms.**—Red Clover Blossoms; *Ger.* Rothe Kleeblumen.

**Botanical Origin.**—*Trifolium pratense* Linné.

**Part Used.**—The dried inflorescence.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash N.F. VII.

**Habitat.**—Europe. Naturalized and extensively cultivated in the United States.

**Plant.**—A low growing, common, perennial herb with ascending slender hairy stems bearing trifoliate leaves with broad, bristle-pointed stipules, the leaflets varying from ovate to obovate in outline, frequently notched at the apex, and showing a pale spot on their upper surface. The small butterfly-shaped flowers are borne in ovoid heads that are long or short peduncled, their color varying from magenta to whitish.

**Production.**—Large amounts of this drug are harvested for the market in Michigan by means of a mechanical flower picker.

**Description.**—Heads ovoid with rounded summit from 12 to 25 mm. in length and width, shrivelled, weak red-purple to light brown (from drying), consisting of numerous, small, closely set, papilionaceous flowers arranged on a receptacle. Each flower exhibits a hairy calyx with 5 subulate teeth, one longer than the others, a corolla whose petals are united below, the standard longer than the wings but when recurved appearing shorter, diadelphous stamens (9 and 1) and a slender, simple style; odor fragrant and characteristic; taste sweetish, then slightly bitter.

**Constituents.**—*Volatile oil, coumaric acid, salicylic acid, sitosterol, myricyl alcohol, hentriacontane, heptacosane, isorhamnetin, the glycosides, trifoliin, isotrifoliin and trifolianol, fatty acids, sugar, etc.*

**Uses.**—Red Clover Blossoms are employed empirically in the form of fluid-extract, compound fluidextract, compound syrup and infusion as an antispasmodic and expectorant in whooping cough and bronchitis; an extract is used in an ointment as a local application to ulcers. The ground blossoms are used in antiasthmatic cigarettes.

**Average Dose.**—4 Gm. (60 grains). **Preparation.**—Fluidextract, 4 cc. (1 fl.dr.).

#### HÆMATOXYLON (HEMATOXYLON)

**Synonyms.**—Logwood, Campeachy Wood, Blackwood; *Fr.* Bois de Sang, Bois de Campêche; *Ger.* Blutholz, Campecheholz.

**Botanical Origin.**—*Hæmatoxylon campechianum* Linné.

**Part Used.**—The heartwood.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter (N.F. V).

**Habitat.**—Central America.

**Plant.**—A tree averagely 7 m. in height but attaining a height of about 15 m. under favorable environment. Its trunk is crooked and covered with rough bark. This bears crooked branches showing numerous white lenticels and numerous sharp spines. The leaves are alternate, paripinnate, with 3 or 4 pairs of sessile, obcordate leaflets. The sweet smelling flowers are arranged on axillary racemes near the ends of the branches and are characterized by the brownish-purple calyx and yellow corolla. The fruit is a slender, membranous, lanceolate, compressed pod, 1- or 2-seeded, dehiscent down the center of each valve.

**Production and Commerce.**—While native to Central America, the logwood tree has been naturalized in the West Indies. The trees are felled when about 10 years old. The bark and sapwood are removed and the heartwood remaining is cut into logs or billets about 13 feet long and sent into commerce. These vary from a purplish-red to blackish-brown color externally, are hard and heavy and have a reddish-brown internal color. For pharmaceutical purposes it is subsequently cut into chips which have a reddish-brown aspect. On long exposure to the air, logwood chips develop a metallic lustre, due to a violet colored substance with a greenish metallic luster, hæmatein ( $C_{16}H_{12}O_8$ ), being formed by oxidation, through the action of a ferment on hæmatoxylin. Such chips are of little or no value pharmaceutically and should be rejected. The market supply comes from Campeachy, Honduras, and from St. Domingo and Jamaica. Campeachy Logwood is considered the best. About 400,000,000 pounds of logwood are annually consumed. The chief use of the article is as a dye-wood. From this, extract of logwood is prepared, large amounts of which are consumed by the dye industry. Logwood extract is imported from Jamaica and France.

**Description.**—The drug usually occurs as small chips of variable size of a reddish-brown color externally, or occasionally as a coarse reddish powder. The fracture of the thinner chips is tough-fibrous, the freshly fractured or cut

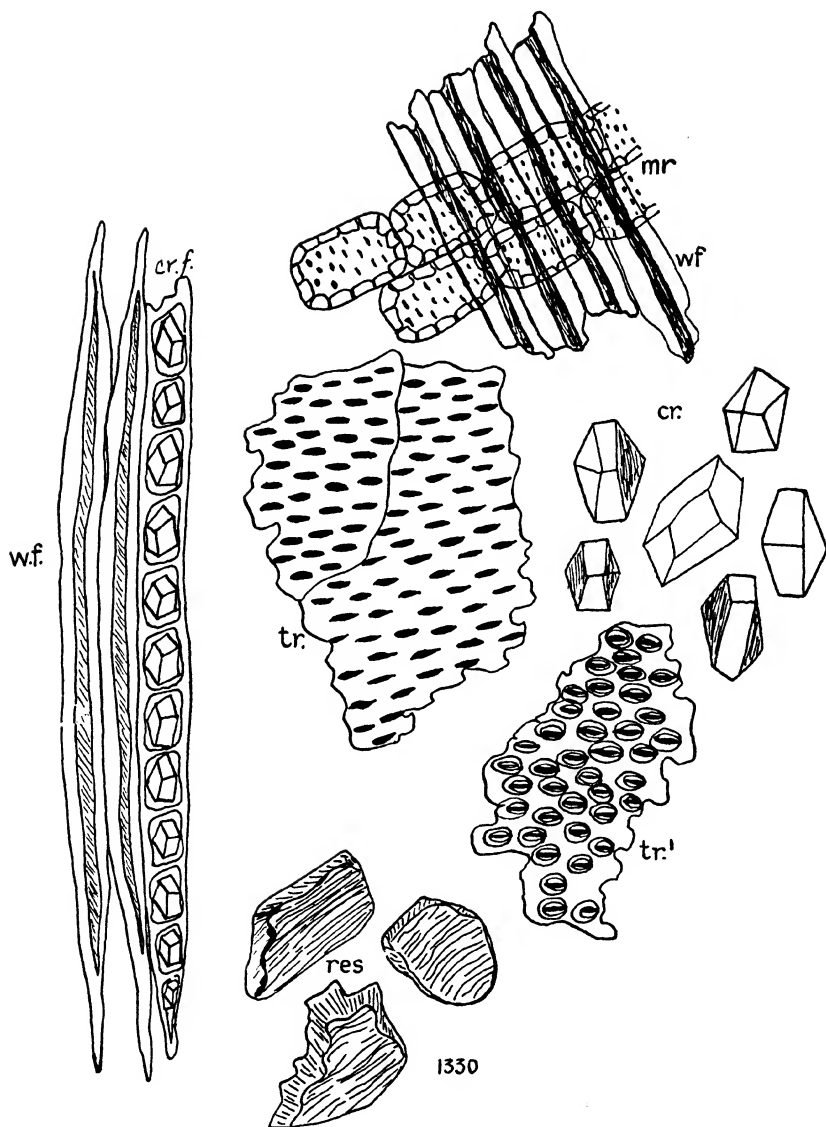


FIG. 212.—Powdered Haematoxylon. *wf*, wood fibers; *crf*, crystal fiber; *mr*, medullary ray crossing wood fibers as observed in a fragment cut radial-longitudinally; *tr*, pitted tracheæ; *tr'*, trachea with bordered pores; *cr*, monoclinic prisms of calcium oxalate; *res*, resin masses. (Drawn by Izzo.)

surface exhibiting a dark yellowish-red aspect; odor indistinct; taste sweetish and astringent.

Hæmatoxylon imparts a yellowish color to slightly acidified water, the color being changed to purple or violet-red by alkaline solutions.

**Histology.**—Transverse sections show many irregular concentric zones of wood fibers and crystal fibers alternating with wood parenchyma, the latter

surrounding tracheæ, arranged either singly or in groups of 2 or 3. Parallel medullary rays traverse the transverse section. In tangential sections the medullary-rays range in width from 1 to 7 rows of cells.

**Powdered Drug.**—Reddish-brown. Numerous elongated, deep brown wood fibers with thickened walls, adhering to which are frequently found crystal fibers containing monoclinic prisms of calcium oxalate, the latter up to  $30\mu$  in length; tracheæ with simple pits or bordered pores; medullary ray cells; fragments of tissue containing resin cells with reddish-brown resin masses; cells containing tannin.

**Constituents.**—*Hæmatoxylin* ( $C_{16}H_{14}O_6 + 3H_2O$ ), volatile oil, *tannin*, a trace of hæmatein, quercetin and calcium oxalate.

**Uses.**—Unfermented logwood is employed as an astringent. The partly fermented article is widely used in the arts in the preparation of a dye and an ink.

**Average Dose.**—2 Gm. (30 grains).

#### KRAMERIA (KRAMERIA)

**Synonyms.**—*Rhatany*; *Ger.* Ratanhiawurzel, *Fr.* Ratanhia.

**Botanical Origin.**—(1) *Krameria triandra* Ruiz et Pavon and (2) *Krameria argentea* Martius.

**Part Used.**—The dried root.

**Purity Rubric.**—Not more than 1 per cent. of foreign organic matter. It yields not more than 2 per cent. of acid-insoluble ash. *Krameria* more than 1 cm. in thickness shall be rejected. N.F. VII.

**Habitat.**—(1) Peru and Bolivia; (2) Brazil.

**Plants.**—Shrubs of low stature with spreading branches and grayish-brown bark. The leaves are simple, entire, obovate and silvery-gray hairy. The inflorescences are racemes of red flowers each possessing a cruciform calyx of 4 scarlet-red sepals, 4 red petals, 4 monadelphous stamens and a monocarpellary pistil with a one-celled ovary. The fruit is an indehiscent 1- to 2-seeded pod.

**Production and Commerce.**—*Krameria triandra* grows on the sand slopes of the Cordilleras range in Bolivia and Peru. Its root is known in commerce as Peruvian *Krameria* or Knotty *Krameria* and is shipped to this country mainly from Peru.

*Krameria Ixina* grows in United States of Colombia, the provinces of Pernambuco and Goyaz of Brazil and in British Guiana. Its root is commercially known as Savanilla *Krameria* and has been imported from United States of Colombia.

*Krameria argentea* grows in northeastern Brazil. Its root is known in commerce as Pará or Brazilian *Krameria* and is exported from Pará and Rio de Janeiro, Brazil.

**Description.**—**Peruvian Rhatany** (Knotty *Krameria*) consists of a knotty, several headed crown with numerous branching roots of variable length and not more than 1 cm. in thickness, cylindrical or somewhat tapering, flexuous or wavy, externally dusky red to moderate brown, the crown with rough, scaly cork, the roots smooth or slightly longitudinally wrinkled and devoid of trans-

verse fissures; fracture of bark slightly fibrous, of wood tough and splintery; internally bark pinkish-brown and less than  $\frac{1}{3}$  the radius of the root, readily separable in young roots from the weak orange to weak yellowish-orange and finely radiate wood; odor indistinct; wood nearly tasteless, bark astringent.

**Pará or Brazilian Rhatany** usually consists of roots separate from the crown, less flexuous and tapering than those of Peruvian Rhatany and usually not exceeding 12 mm. in thickness; externally dark purplish-brown or chocolate-brown and marked with many transverse fissures; fracture of bark slightly



FIG. 213.—Peruvian or "knotty" Krameria.  $\times \frac{1}{2}$ .

fibrous, of wood less tough than Peruvian Rhatany; internally bark about two-fifths or more of the radius, both bark and wood darker than Peruvian Rhatany, the bark reddish-brown and the wood reddish; odor indistinct; taste of bark strongly astringent, coloring the saliva red. The wood is nearly tasteless.

**Powdered Peruvian Rhatany.**—Moderate brown. Starch grains simple or 2- to 4-compound, the individual grains spheroidal, ellipsoidal or plano-convex, up to  $35\mu$  in diameter and sometimes with a central radial or stellate hilum; bast fibers slightly wavy in outline, non-lignified, with long drawn out ends; fragments of narrow, spindle-shaped wood fibers having thick, porous, slightly lignified walls associated with tracheæ and tracheids with simple or bordered pores; numerous parenchyma cells with yellowish or reddish-brown walls and

frequently contents; few calcium oxalate crystals in the form of monoclinic prisms, from 10 to 100 $\mu$  in length, and occasionally microcrystals.

**Powdered Pará Rhatany.**—Deep red-brown; parenchyma and suberous elements richer in reddish-brown coloring substance; bast fibers larger and thicker walled than in Peruvian Rhatany; tracheæ also larger.



FIG. 214.—Savanilla Krameria,  $\times 14$ . (Photograph by Stoneback.)

**Constituents.**—*Krameria-tannic acid* (8 to 9 per cent) krameric acid, krameria-red (phlobaphene), starch, etc.

**Use.**—Astringent in chronic diarrhea.

**Average Dose.**—1 Gm. (15 grains).

**Preparation.**—Fluidextractum *Krameria*, N.F. VII, 1 cc. (15 minims).

#### TONKA (DIPTERYX)

**Synonyms.**—Tonka Bean, Tonquin Bean, Tonka Seed, Tonco Bean; *Ger.* Tonka-bohnen; *Fr.* Semina Tonco.

**Botanical Origin.**—*Dipteryx odorata* (Aubl.) Willd. (Dutch Tonka) and *Dipteryx oppositifolia* (Aubl.) Willd. (English Tonka).

**Part Used.**—The cured, dried ripe seeds.

**Plants and Habitats.**—Trees with indehiscent fruits, each ovate and containing a single brownish-violet seed. *Dipteryx odorata* is a native of Guiana and *Dipteryx oppositifolia* of Brazil.

**Production.**—The fruits are collected after falling from the trees by the natives who crush them between stones, separate the seeds and allow them to dry on flat rocks in the sun. They are then shipped to Angostura, Venezuela, Surinam or Trinidad where they are steeped in rum, removed and allowed to ferment and dry. During this curing process the fragrant principle coumarin

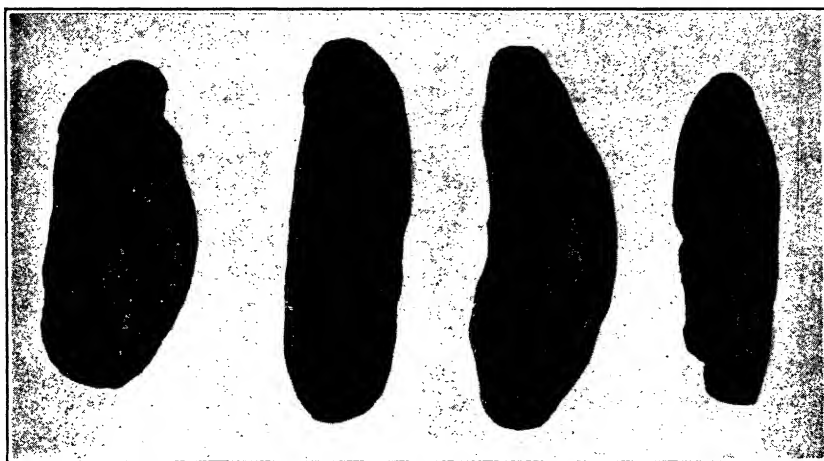


FIG. 215.—Tonka seeds. The whitish areas seen on the exterior represent coumarin crystals.

is developed, some of which crystallizes on the outside of the seed coat as a whitish frost. They are packed in cases or casks for shipment. The commercial varieties of Tonka Beans are the Dutch or Angostura and the English or Pará. The Dutch variety is the larger and more esteemed. During 1945, 860,810 pounds of Tonka Beans were imported into this country from Trinidad, Colombia, Venezuela and Brazil.

**Description.**—Seed oblong or oblong-ovoid, somewhat flattened, from 3 to 5 cm. in length and from 10 to 15 mm. in breadth; externally nearly black, usually covered with white acicular crystals of coumarin, the seed coat deeply wrinkled; internally yellowish-brown or dark yellow showing 2 large, oily, plano-convex cotyledons enclosing a plumule and a short fleshy radicle; odor fragrant; taste aromatic and pungent.

**Histology.**—The chief diagnostic structures are the palisade cells of the seed coat which are rectangular in cross section and polygonal in surface section with relatively thin walls and broad lumina, the latter containing a black substance; the irregularly-shaped column cells up to  $25\mu$  in height and 30 to  $50\mu$  in breadth, the isodiametric parenchyma cells of the cotyledons which, when the sections are cleared in ether and mounted in iodine solution, show elongated



aleurone grains and rounded starch grains; the separate aleurone grains which are irregularly elongated and up to  $35\mu$  in length and the rounded simple starch grains, many of which are eroded and up to  $9\mu$  in diameter.

**Constituents.**—Up to 10 per cent. of *coumarin* (ortho-oxycinnamic anhydride) which occurs as colorless fragrant crystals possessing an aromatic odor and bitter taste; starch, sugar, 25 per cent. of a fixed oil, gum, etc.

**Uses.**—Tonka beans are used with Vanilla beans in the preparation of a flavoring extract. They are also used in the perfume industry and as a natural source of coumarin.

**Coumarin (Coumarinum) N.F.**,  $C_6H_4(CH)_2OCO$ , is the lactone of ortho-hydroxycinnamic acid. It occurs in colorless, prismatic crystals which possess a fragrant odor, and a bitter, aromatic, burning taste. 1 Gm. is soluble in 400 cc. of cold water. It is freely soluble in alcohol and in fixed and volatile oils. It melts between  $68^\circ$  and  $70^\circ C$ .

Coumarin is widely distributed in the plant kingdom being found in the yellow melilot, sweet scented vernal grass, deer's tongue, sweet woodruff, in several orchids and clovers, etc. It is used as a flavoring agent and enters into Aromatic Castor Oil, N.F.

#### FENUGREEK (FOENUM GRAECUM)

**Synonyms.**—Semen Foenigraeci, Greek Hay Seed; *Ger.* Bockshornsamensamen.

**Botanical Origin.**—*Trigonella Foenum graecum* L.

**Part Used.**—The dried ripe seeds.

**Habitat.**—Mediterranean countries; cultivated extensively in Southern Europe, Northern Africa, and India.

**Plant.**—An annual herb with pinnately 3-foliate leaves with ovate (obovate) leaflets and white papilionaceous flowers.

**Commercial Source.**—French Morocco and India.

**Description.**—Seeds oblong-quadrangular to rhomboidal or mitten-shaped, somewhat flattened, 3–5 mm. long and 2–3 mm. broad; externally yellowish brown, one of the flat surfaces marked with an oblique furrow which divides the seed into unequal parts, the larger containing the cotyledons, the smaller the radicle; hard; internally yellowish to yellowish-brown, the embryo waxy, the endosperm glassy; odor indistinct, when crushed resembling elm bark; taste mucilaginous, farinaceous, and slightly bitter.

**Powdered Drug.**—Yellowish-brown; fragments of the seed coat with a mucilaginous cuticle, groups of polygonal-shaped cross sections of palisade cells appearing like stone cells with narrow to broad lumina and pore canals; the column cells hour-glass shaped in transverse view, circular and thick-walled in surface view with radiating ribs and up to  $15\mu$ ; numerous fragments of mucilage cell zone of endosperm with mucilaginous wavy inner walls, few fragments of aleurone layer of endosperm; numerous yellow fragments of the embryo containing small aleurone grains and oil droplets.

**Constituents.**—*Mucilage* (about 28 per cent.), *trigonelline*, choline, an odorous oil and proteins (about 22 per cent.).

**Uses.**—The ground drug is employed in domestic medicine for the preparation of poultices, enemata, and plasters; in veterinary cattle and condition powders.

### PHYSOSTIGMA (PHYSOSTIGMA)

**Synonyms.**—Calabar Bean, Ordeal Bean, Esere Nut; *Ger.* Kalabarbohne; *Fr.* Fève de Calabar.

**History.**—Physostigma was used by the negroes of the Calabar coast of W. Africa as an ordeal to persons accused of crimes. It was introduced into medicine in 1840 by Dr. Daniell, a missionary in western Africa and became official in the U.S.P. of 1870.

**Botanical Origin.**—*Physostigma venenosum* Balfour.

**Part Used.**—The dried ripe seed.

**Standard of Assay.**—Not less than 0.15 per cent. of Physostigma alkaloids.

**Habitat.**—West Africa.

**Plant.**—A perennial woody climber with long, scandent stems bearing pinnately-trifoliate, stipulate leaves, each having 3 large ovate, acuminate leaflets. The inflorescence is a pendulous axillary raceme of purplish papilionaceous flowers. The fruit is a compressed, brownish, reticulated legume, containing two or three reniform or oblong, brownish seeds.

**Production and Commerce.**—The plant grows wild along the banks of streams in the vicinity of the Gulf of Guinea in western Africa. The seeds are collected when the fruits are mature. The commercial supplies are imported from British West Africa.

**Description.**—The drug occurs as entire, oblong, ellipsoidal, more or less reniform, anatropous seeds, from 16 to 30 mm. long and from 10–15 mm. in thickness; externally reddish or chocolate brown, smooth except near the groove where it is somewhat wrinkled; groove about 2 mm. broad and extending nearly the whole length of the convex edge and in which are sometimes found the remains of a white funiculus; margins of the hard spermoderm on both sides of the groove yellowish-red or brownish-red and somewhat elevated; embryo with two large, white, plano-convex cotyledons and a small hypocotyl; odor indistinct; taste starchy.

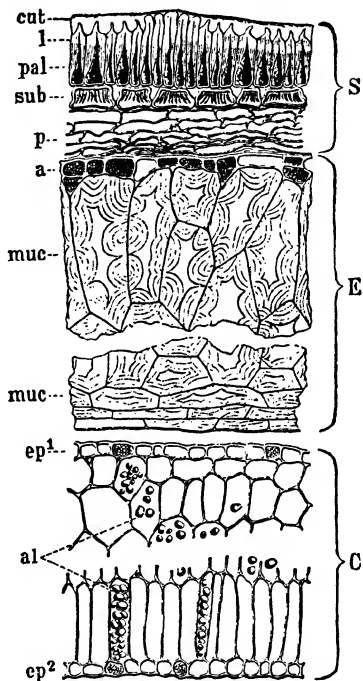


FIG. 216.—Fenugreek. Seed in transverse section.  $\times 160$ . S, spermoderm consisting of pal palisade cells with cut cuticle and l light line, sub subepidermal layer, and p. parenchyma; E, endosperm consisting of a aleurone cells and muc mucilage cells; C, cotyledon, with ep<sup>1</sup> and ep<sup>2</sup> epidermal layers and al aleurone cells of mesophyll. (After Winton "The Microscopy of Vegetable Foods," J. Wiley & Sons.)



FIG. 217.—*Physostigma venenosum*. 1. Flowering branch. 2. Pistil. 3. Terminal part of style and appendage. 4. Transverse section through appendage. 5. Legume. 6, 7. Seeds. 8. Cross section of dry seed. 9. Portion of embryo showing base of one cotyledon, the plumule and the hypocotyl. (After Bentley and Trimen.)

**Powdered Drug.**—Grayish-white in color, showing numerous more or less ellipsoidal to reniform starch grains usually with a distinct hilum and often with radiating or irregular fissures, the grains from 5 to 150 $\mu$  in diameter or length; fragments of thick-walled, non-lignified, brownish palisade cells with brownish contents and irregular, porous and colorless cells containing a red

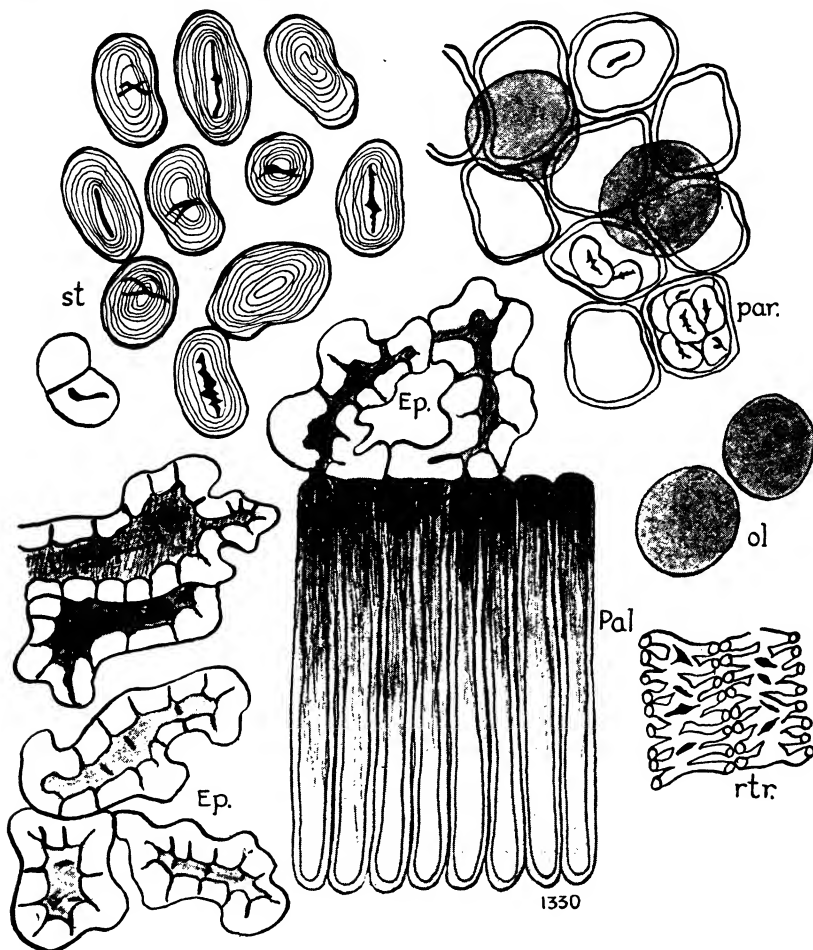


FIG. 218.—Powdered *Physostigma*, *st*, starch; *par*, parenchyma of mesophyll of cotyledon with starch and fixed oil content; *ol*, oil globules; *ep*, column cells of seed coat with non-lignified walls and reddish contents; *pal*, palisade cells of seed coat; *rtr*, reticulate tracheæ. (Drawing by Izzo.)

colored substance from the hard seed coat; fragments of large, polygonal, thin, colorless walled cells of the cotyledons containing starch and fixed oil; reticulate tracheæ.

**Constituents.**—The alkaloids *physostigmine* (eserine) (0.1 to .25 per cent.), *eseridine*, *calabarine* (liquid), *physovenine*, *eseramine*; phytosterol glucosides; stigmasterol, sistosterol; about 20 per cent. of proteins; about 45 per cent. of starch; etc. *Physostigmine* ( $C_{15}H_{21}O_2N_2$ ) occurs in colorless or pinkish crystals

slightly soluble in water and readily soluble in alcohol. Upon warming its aqueous solution with diluted KOH, it takes on a red color.

**Uses.**—Physostigma is used as a motor depressant in tetanus and strychnine poisoning and, in combination with cathartics, as a stimulant to the unstriated muscle of the intestine. **Average Dose.**—0.1 Gm. ( $1\frac{1}{2}$  grains). **Substitutes.**—(1) Seeds of *Physostigma cylindrospermum* Holmes which are subcylindrical, about 4 cm. long and possess a shorter groove. (2) Seeds of *Entada phaseoloides* (L.) Merrill (*Entada scandens* Benth) that are lenticular, flat, brown and glossy and about 5 cm. in width. (3) Seeds of *Mucuna urens* DC. which are brownish and rounded.

**Physostigmine Salicylate U.S.P.** (*Eserine Salicylate*) is the salicylate of an alkaloid usually obtained from the dried ripe seed of *Physostigma venenosum* (Fam. *Leguminosæ*). It occurs as white or pale yellow, shining crystals which acquire a red tint when long exposed to light and air. 1 Gm. dissolves in 75 cc. of water. It is employed in solutions in the eye as a myotic to hasten the return of the pupil to normal and in the high intraocular tension of glaucoma; by hypodermic injection as a cathartic, and as an antidote for atropine and curare poisoning, also to inhibit the action of the enzyme cholinesterase on acetylcholine, thus prolonging the stimulating action of the latter on the muscle. **Average Dose.**—2 mg. ( $\frac{1}{30}$  grain).

#### RED SAUNDERS U.S.P. (SANTALUM RUBRUM)

**Synonyms.**—Red Sandal Wood, Red Santal, Ruby Wood, Chandam; *Ger.* Rothes Santelholz; *Fr.* Santal Rouge.

**Botanical Origin.**—*Pterocarpus santalinus* Linné filius.

**Part Used.**—The heartwood.

**Habitat.**—Indo-China and Southern India. Cultivated in the Philippine Islands.

**Plant.**—A tree with spreading branches, trifoliate leaves and spikes of yellow papilionaceous flowers. The leaflets are oval and emarginate. The fruit is an orbicular, 2-seeded legume.

**Commercial.**—Red Saunders is imported from Madras.

**Description.**—It occurs in the form of a coarse powder of a purplish, moderately reddish-orange or reddish-brown color or in dusky red to dark reddish-orange chips or raspings; odor indistinct, taste slightly astringent. 0.5 Gm. of Red Saunders mixed with 10 cc. of alcohol imparts a reddish brown to reddish-orange color to the alcohol. It imparts no color to water.

**Powdered Drug.**—Numerous wood fibers with sharply pointed and occasionally forked ends from 300 to 750 $\mu$  in length, with greatly thickened, porous, orange to yellowish-orange, unevenly thickened, lignified walls and the lumina filled with fine granules; few tracheæ with simple and bordered pores and containing orange to yellow, resinous masses; few crystal fibers with monoclinic prisms of calcium oxalate up to 20 $\mu$  long; occasional medullary rays 1 cell wide and from 3 to 6 cells deep. Mounts in chloral hydrate solution are of a deep red color.

**Constituents.**—*Santalin* which occurs in blood red needles and *desoxysantal* (red coloring principles), the colorless crystalline substances pterocarpin, santal and homopterocarpin; tannin, etc.

**Use.**—Coloring agent in Tinct. Lavender Co. and other preparations.

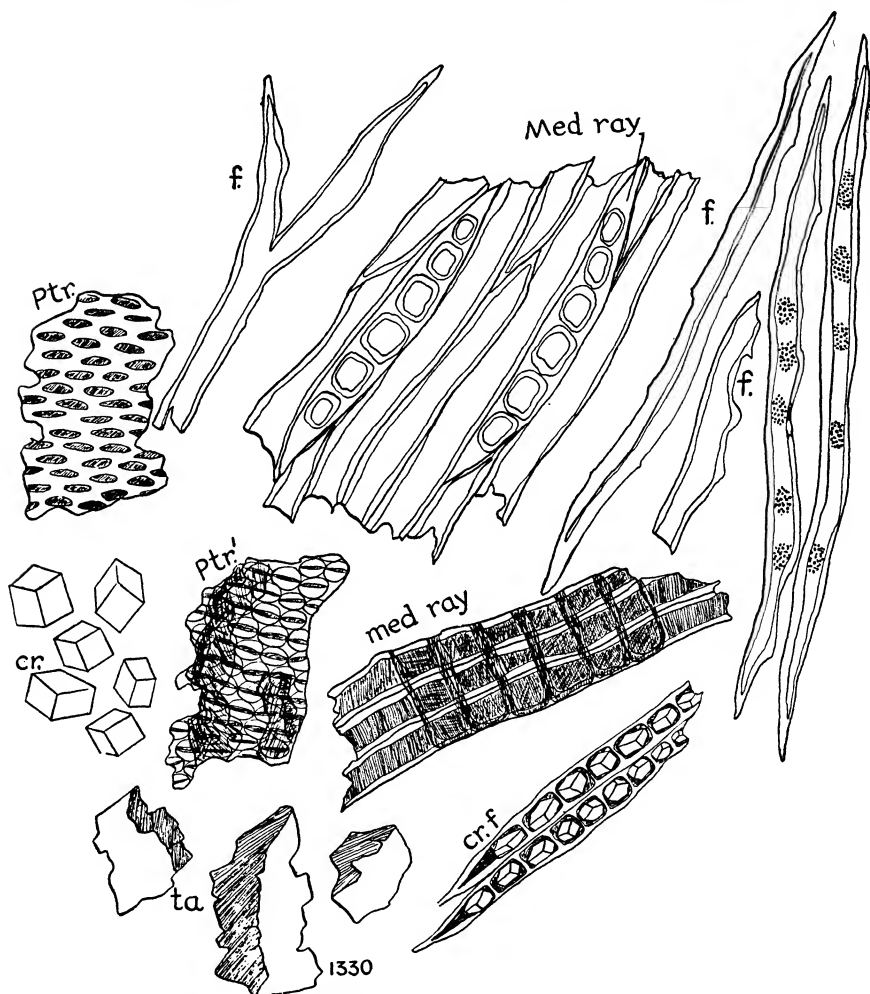


FIG. 219.—Powdered Red Saunders. *f*, wood fibers, the two on the extreme right showing granular contents; *ptr.*, pitted trachea with simple pores; *ptr'*, trachea with bordered pores; *cr.*, monoclinic prisms of calcium oxalate; *cr.f.*, two crystal fibers adherent to wood-fibers; *ta*, tannin masses; *med ray* (above), medullary ray in tangential section associated with wood-fibers; *med ray* (below), medullary ray in radial-longitudinal section crossing three wood-fibers. (Drawing by Izzo.)

#### ACACIA U.S.P. (ACACIA)

**Synonyms.**—*Gum Arabic*, Gum Senegal, Gum Acacia, Galam Gum, Egyptian Thorn; *Fr.* Gummie arabique vraie; *Ger.* Arabisches Gummi.

**History.**—Gum Arabic has been reported by Herodotus (5th century B.C.) as being used by the ancient Egyptians as an adhesive. Its use in medicine is

mentioned on several of the Egyptian papyri. Hippocrates refers to it in medical works published between 450–350 B.C. It was carried from the Gulf of Aden to Egypt in the 17th century B.C.

**Botanical Origin.**—*Acacia Senegal* (L.) Willdenow (*A. Verek* Guill. et Perr.) or some other African species of *Acacia*.

**Part Used.**—The dried gummy exudation from the stems and branches.

**Purity Rubric.**—It yields not more than 1 per cent. of water-insoluble residue, not more than 4 per cent. of total ash, not more than 0.5 per cent. of acid-insoluble ash, and not more than 15 per cent. of moisture.

**Habitat.**—Africa.

**Plant.**—*Acacia Senegal* is a tree, with grayish bark, growing to the height of about 6 m. and forming open forests in the Anglo-Egyptian Sudan, Sennaar and Gedaref. It is called “Verek” by the natives of Senegambia and “Hashab” by those of Kordofan. Its leaves are bipinnate. Its inflorescence is a spike of yellow regular flowers. Its fruit is a broad legume containing 5 or 6 seeds.

**Production and Commerce.**—Most of the official gum, representing the variety known as “Kordofan Gum,” is yielded by cultivated trees of *Acacia Senegal* which form forests known as “geneinas” that are owned by Arab sheiks. Only a very small amount is collected from wild untapped trees. These trees are usually tapped from February to May when the fruits called “Arad” are ripe. Tapping is accomplished by making a transverse incision with a small axe and tearing off a thin strip of bark from 2 to 3 ft. long and 1 to 3 in. broad, care being exercised to leave a thin layer of inner bark covering the wood. The gum slowly exudes as a viscous liquid, collects in a tear at the base of the wound and gradually hardens. In from 3 weeks to 2 months, depending upon the time of the year, the tears are ready to be collected. The natives pick the tears and place them in leather bags which, when full, are emptied on a heap. The gum is subsequently bleached by the sun’s rays and garbled by native girls, who remove pieces of bark and sieve out the sand. In the cleaned state the Kordofan Gum is packed into sacks, carried on the backs of camels to Khartoum, El Obeid and Omduram and consigned by rail to Port Sudan and Cairo from whence it enters the world’s commerce, or, it may be reshipped to Smyrna, Athens, Trieste or other Mediterranean ports for further consignment. Senegal Gum is exported from Senegambia to Bordeaux and Marseilles and the United States. This variety usually occurs in larger tears which are less fissured and more colored than the Kordofan gum. It generally contains some vermiform tears.

The two chief commercial varieties of Gum Arabic are (1) Kordofan Gum and (2) Senegal or West African Gum. The former is considered the best variety.

The commercial supplies of Kordofan Gum are chiefly imported into the U. S. A. from Cairo and indirectly through London. Senegal Gum is imported from French Africa. During 1945 there were imported into this country 16,812,983 pounds of Gum Arabic, the countries shipping the same in order of amounts being Anglo-Egyptian Sudan, Nigeria, Egypt and Iran.

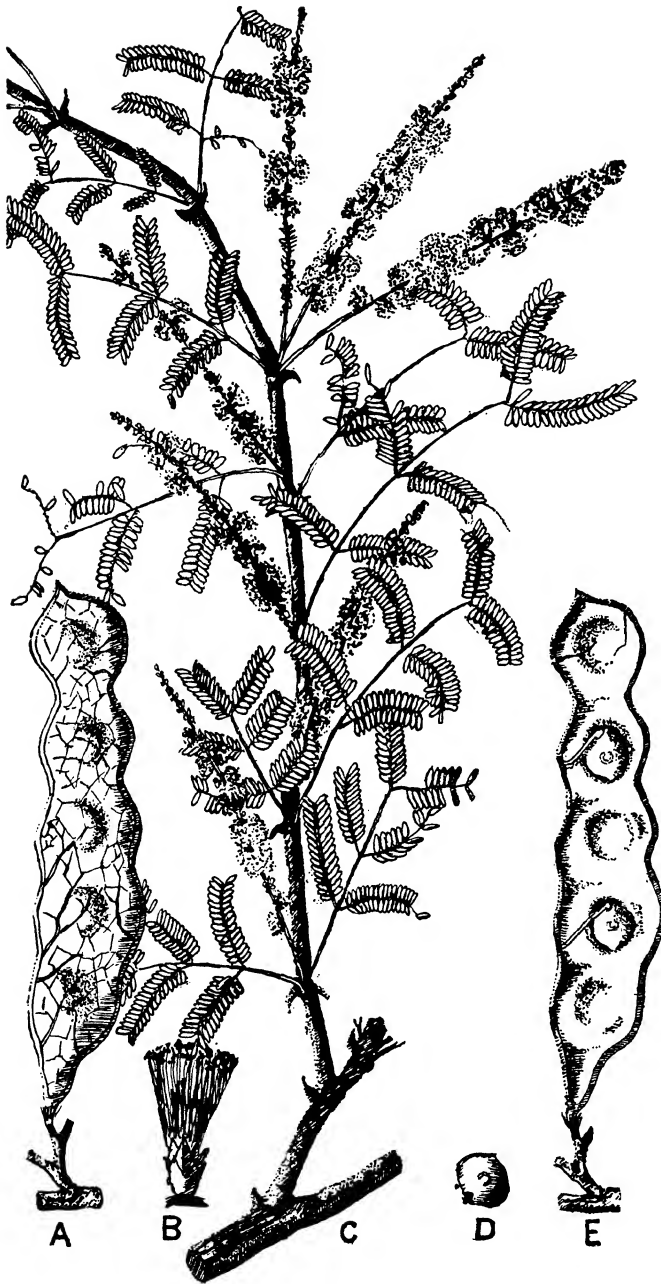


FIG. 220.—*Acacia Senegal*. Fruit viewed externally (A); flower (B); branch of plant (C) showing short, sharp, curved thorns, bipinnate leaves and inflorescences; seed (D); internal aspect of leguminous fruit (E).



**Description.**—*Unground Acacia* occurs in spheroidal tears up to 32 mm. in diameter or in broken, angular fragments, varying in color from white to yellowish white to light amber-colored; translucent or somewhat opaque from the presence of numerous minute fissures; very brittle; fractured surface glass-like, sometimes iridescent; almost odorless; taste mucilaginous.

*Flake Acacia* occurs in white to yellowish white thin flakes appearing, when examined under the microscope, as colorless, striated fragments. It is more quickly soluble in water than ordinary unground Acacia and forms a clear, colorless solution.

It is insoluble in alcohol but slowly soluble in twice its weight of cold water, forming a mucilaginous solution which flows readily and which is acid to litmus. Acacia is precipitated from solutions containing it by alcohol, basic lead acetate test solution, saturated solution of sodium borate and ferric chloride test solution.

**Powdered Drug.**—White to yellowish-white. In angular microscopic fragments. It contains few or no vegetable tissues or starch grains.

**Identity Test.**—When 0.2 cc. of diluted lead subacetate T.S. is added to 10 cc. of a 2 per cent cold solution of Acacia, a flocculent or curdy, white precipitate is immediately produced.

**Constituents.**—*Arabic acid* in combination with *calcium*, *magnesium* and *potassium*, an oxydase enzyme, water, and ash.

**Uses.**—Acacia is employed medicinally as a demulcent; pharmaceutically it is used as an emulsifying agent and also to impart viscosity to mixtures containing insoluble and heavy powders. The bulk of the acacia imported is used in the textile, confectionery, mucilage, paste and polish industries.

**Preparations.**—Acacia Mucilage, U.S.P. 15 cc. (4 fl. dr.); Acacia Syrup, N.F.; Cod Liver Oil Emulsion, U.S.P. 15 cc. (4 fl. dr.); Liquid Petrolatum Emulsion, U.S.P. 30 cc. (1 fl. oz.); Liquid Petrolatum Emulsion with Phenolphthalein, N.F. 15 cc. (4 fl. dr.); Copaiba Mixture, N.F. 8 cc. (2 fl. dr.); Compound Chalk Powder, N.F. 2 Gm. (30 grains); Black Lotion, N.F.

**Adulterants.**—(1) Mesquite Gum is obtained from *Prosopis chilensis*, a leguminous plant indigenous to Mexico. It occurs in brownish tears of variable size. It differs from Acacia in being usually darker in color and in not precipitating from its solution when solutions of ferric chloride, sodium borate or lead subacetate are added. (2) Artificial Gums made from starch or dextrin. (3) The powdered drug has been admixed with starch and white dextrin. (4) Talka gum from *Acacia Seyal* consisting of tears of various colors, the nearly colorless and brown shades predominating.

**Allied Drug.**—Gummi Indicum, also called "Ghatti Gum" or "Indian Gum" is an exudation from the stems of *Anogeissus latifolia* Wall. (Fam. *Combretaceæ*), a tree indigenous to India and Ceylon. It occurs in vermiform or rounded, transparent, brittle tears of different colors. It may be distinguished from Acacia by its dull surface, uniform glassy fracture, fewer cracks, and the presence of many vermiform tears. It contains arabic acid and its

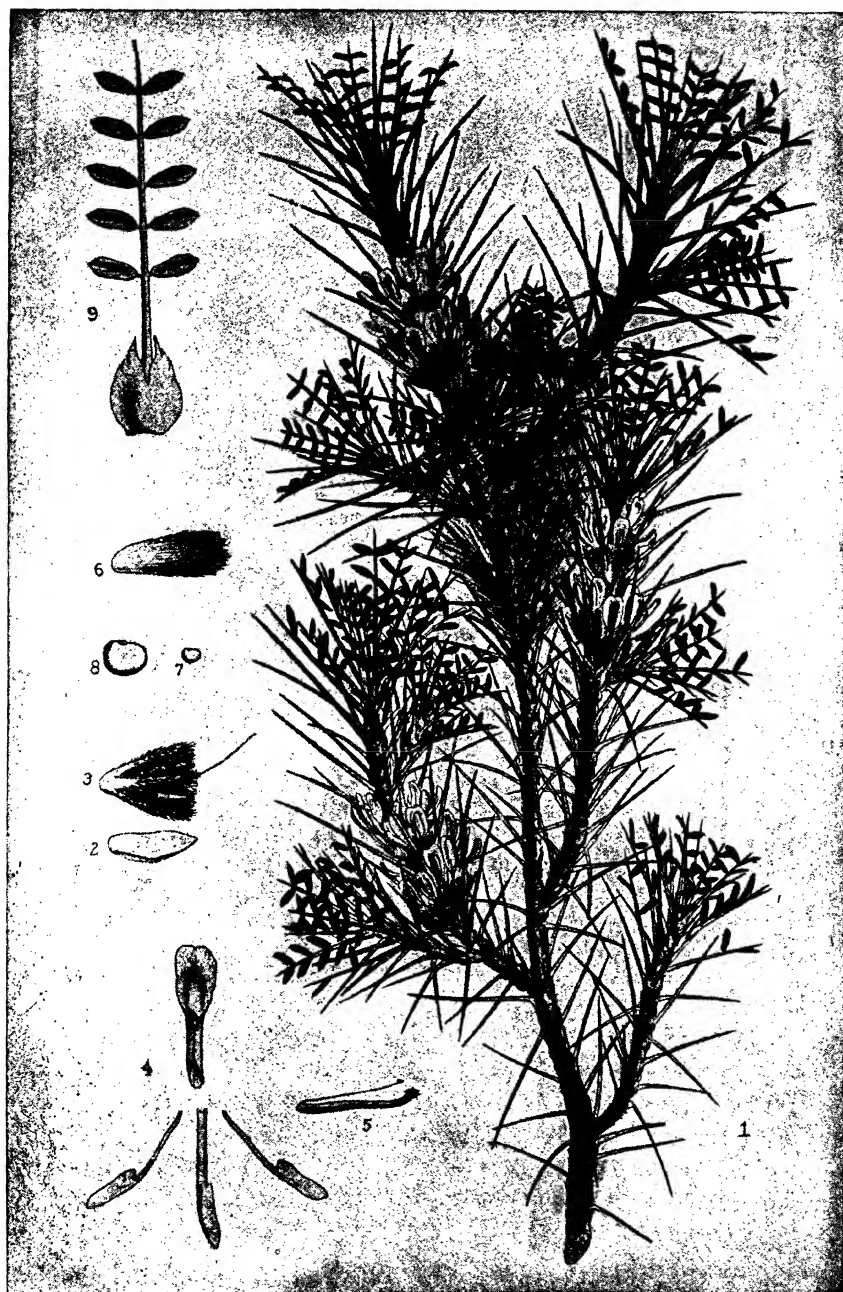


FIG. 221.—*Astragalus gummifer*. 1. Branch with flowers. 2. Bract. 3. Calyx. 4. Petals. 5. Stamens. 6. Legume. 7, 8. Seed. 9. A leaf. (After Bentley and Trimen.)

salts. A 10 per cent. solution of tannic acid will produce a precipitate when mixed with a 1 per cent. solution of Ghatti Gum.

TRAGACANTH U.S.P. (TRAGACANTHA)

**Synonyms.**—*Gum Tragacanth*, Hog Gum, Goat's Thorn; *Ger.* Traganth; *Fr.* Gomme Adragant.

**Botanical Origin.**—*Astragalus gummifer* Labillardiere or other Asiatic species of *Astragalus*.

**Part Used.**—The dried gummy exudation.

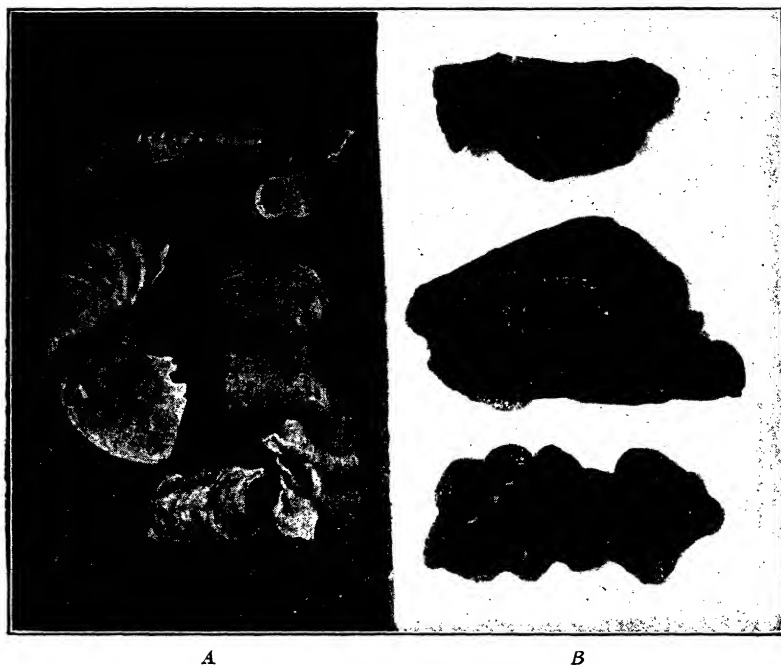


FIG. 222.—A, Tragacanth; B, Indian Gum,  $\times 45\times 7$ . (Photograph by Stoneback.)

**Habitat.**—Western Asia and Southeastern Europe. *Astragalus gummifer* occurs in Northern Kurdistan, Asia Minor, Syria and Armenia.

**Plants.**—Thorny, much branched shrubs with reddish-gray bark attaining a height of about 1 m. Their leaves are pinnately-compound with 10 to 15 pairs of obovate, grayish-green leaflets. Their flowers are papilionaceous, yellow, with 10 diadelphous stamens. Their fruit is a small hairy legume containing a single, brown, kidney-shaped seed.

**Production and Commerce.**—A number of species of *Astragalus* grow wild in the mountainous districts of Kurdistan, Iran, Iraq, Syria, Asia Minor, Armenia, Greece and Russia. The gum is the result of the transformation of some of the walls of the pith and medullary-ray cells to mucilage. It exudes spontaneously to the surface of the bark, but is obtained on a large scale by

punctures or transverse incisions made in the main stem and older branches. Frequently a wedge-shaped piece of wood is forced into the incision by the collector in order to enlarge the wound so that the gum will exude more freely. It is left in the cut for a day or two before being removed. The gum is allowed to dry on the bark for two days before it is collected. The nature of the incision governs the shape of the product. The length of time consumed in drying influences the color of the product. It is carried to Bagdad, Smyrna, Istanbul and Persian Gulf ports where it is garbled and assorted into three varieties, viz.: Flake, Vermiform and Common Tragacanth.

Flake Tragacanth, also called Persian, Syrian or Leaf Gum, is considered the highest grade on the market. This occurs in ribbon-like, lamellated, nearly colorless pieces.

Vermiform Tragacanth occurs in elongated, narrow, twisted strings or coils.

Common Tragacanth or "Tragacanth in sorts" occurs in rounded or irregular shaped tears of brownish, waxy aspect. This grade represents gum which has exuded through naturally produced ruptures in the bark. Most of the Tragacanth imported into this country recently is produced in Persia. Great quantities are gathered in Shiraz, Persia. It is carried by caravan from Teheran, Ispahan, Sultanabad and Hamadan to Bagdad for export. The finer grades are shipped in cases, the poorer in burlap bags. The Turkish gum comes to us chiefly from Istanbul. Even the very finest grades of Turkish gum have a distinctly yellow cast when compared with the fine Persian grades. Small lots occasionally come from Bombay and Aleppo. Some of the fine Persian gum reaches the United States indirectly through British India and London. Russian Tragacanth is produced in Turkmenistan, in Transcaucasia and Armenia. During 1945 there were imported into this country 2,967,820 pounds of Tragacanth, the supplies coming chiefly from Iran (Persia), Turkey and Iraq. In 1947, 3,062,622 lbs. were imported from Iran, Iraq and India.

**Description.**—In flattened, lamellated, ribbon-like (Syrian) or linear (Vermiform) fragments, either straight or spirally twisted, and from 0.5 to 3 cm. in length and from 0.5 to 2.5 mm. in thickness; nearly colorless, white to weak yellow, translucent, and horny; fracture short; inodorous; taste mucilaginous. Tragacanth is rendered more easily pulverizable by heating it to 50°C.

**Identity Tests.**—(1) If 1 Gm. of the gum be added to 50 cc. of water, it swells and forms a smooth, nearly uniform, stiff, opalescent mucilage devoid of cellular fragments, that does not change in consistency on standing 2 or 3 days. This mucilage slowly darkens when even a small percentage of sodium borate is dissolved in it.

(2) Boil 1 Gm. of Tragacanth with 20 cc. of water until a mucilage is formed, then add 5 cc. of HCl, and again boil the mixture for 5 minutes; no pink or red color develops (*Karaya Gum*).

**Microscopical Characteristics.**—Sections of Tragacanth, previously softened in water, and mounted in glycerin, exhibit lamellæ of mucilaginous walls and a few mostly spherical simple or 2- to 4-compound starch grains, the individual grains being from 3 to 25µ in diameter.

**Powdered Drug.**—White to yellowish-white; numerous angular masses of mucilage with circular or irregular lamellæ; starch grains for the most part simple, spheroidal or ellipsoidal, a few being 2- to 4-compound, the separate grains from 3 to 25 $\mu$  in diameter. Few or no fragments of lignified vegetable tissue should be present (Indian gums).

**Constituents.**—About 60 to 70 per cent. of *bassorin*, a substance which swells but does not dissolve in water; about 30 to 40 per cent. of *tragacanthin* claimed to be composed of arabinose and uronic acids, soluble in water; starch, etc.

**Uses.**—Tragacanth is used pharmaceutically as an adhesive agent in pill masses and troches and as an agent for the suspension of insoluble powders in mixtures. It has been used medicinally as a demulcent.

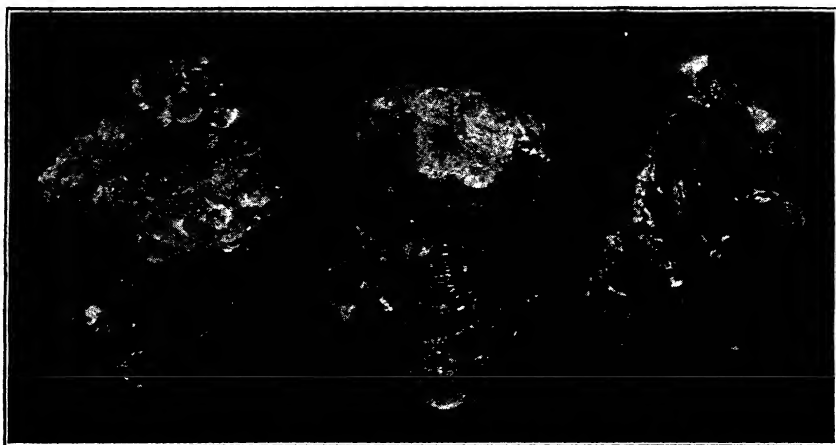


FIG. 223.—Karaya Gum (nat. size).

**Preparations.**—Tragacanth Mucilage, U.S.P. Methylrosaniline Chloride Jelly, N.F., Ephedrine Sulfate Jelly, N.F.

**Substitutes.**—(1) An Indian Gum termed **Karaya** or **Kadaya** Gum, is yielded by *Cochlospermum religiosum* (L.) Alston, a member of the *Bixaceæ* family, growing in India and adjacent countries. This article is largely used by the paste, cigar and ice cream industries. In 1945, more than 6,900,000 pounds were imported into the United States, being shipped from British India and Egypt in bags. The U. S. Dept. of Agriculture requires that it contain not more than 0.7 per cent. of crude fiber. It is found in rounded or vermiform tears with a rough surface and glassy fracture. When softened in water and mounted in glycerin and examined under the microscope, it shows threads of a granular substance, a few rosette aggregates of calcium oxalate up to 30 $\mu$  in diameter, starch grains of spheroidal outline up to 7 $\mu$  in diameter, occasionally chains of bacteria, fungal hyphæ, and sometimes yellowish-brown to reddish-brown fragments, containing lignified sclerenchyma fibers.

When 1 Gm. of Indian Gum is added to 50 cc. of water, an uneven mucilage is formed which contains a few reddish-brown to yellowish-brown fragments.

On stirring it separates in the form of coarse, uneven strings (*distinction from Tragacanth*). When 1 Gm. of Indian Gum is boiled with 20 cc. of water until a mucilage results and 5 cc. of hydrochloric acid is added, and the mixture again boiled for five minutes, a pinkish or reddish color develops (*distinction from Tragacanth*).

(2) **Sterculia Gum** also called *Indian Tragacanth*, obtained from *Sterculia urens* Roxburgh, *Sterculia villosa* Roxburg, *Sterculia tragacantha* Lindley and other species of *Sterculia* (Fam. *Sterculiaceæ*), somewhat resembles Tragacanth and has been used in the form of its powder to adulterate powdered tragacanth. This gum comes from trees growing in Persia and is frequently mixed with Tragacanth. It is naturally in the form of irregular or vermiform, striated, pinkish-brown to yellowish-brown pieces often with attached fragments of bark. It swells and forms a transparent jelly with water. The fragments of the powder are colored pink in a solution of ruthenium red. It has not infrequently been whitened with carbonate of lead in order to disguise its presence.

#### SENNA U.S.P. (SENNA)

**Synonyms.**—*Senna Leaves*; (1) Alexandria or Nubia Senna; *Ger.* Alexandrinische Senna; *Fr.* Séné d' Alexandrie. (2) Indian or Tinnevely Senna; *Ger.* Indische Senna, Sennesblätter; *Fr.* Séné de Tinnevely; Feuilles de Séné.

**History.**—Senna was introduced into Western Europe by the Arabian physicians who preferred the pods to the leaves although they employed both. It was introduced into the U.S.P. in 1820 and has been official in every edition of this work.

**Botanical Origin.**—(1) *Cassia acutifolia* Delile and (2) *Cassia angustifolia* Vahl.

**Part Used.**—The dried leaflets.

**Purity Rubric.**—Not more than 8 per cent. of its stems and not more than 2 per cent. of its pods or other foreign organic matter; it yields not more than 3 per cent. of acid-insoluble ash.

**Habitat.**—(1) The middle and upper Nile districts of Africa. (2) Arabia and Africa.

**Plants.**—*Cassia acutifolia* is a low growing shrub with branched whitish stems, paripinnate, stipulate leaves with pale green leaflets, and large yellow flowers borne in axillary racemes. Its fruit is a broadly elliptical, somewhat reniform, flattened, membranous legume containing 6 or 7 seeds. *Cassia angustifolia* resembles the former species in habit, but its leaflets are yellowish-green, frequently broader, and usually more abruptly pointed; its pods are more narrowly elliptical or reniform and 8 seeded.

**Production and Commerce.**—Alexandria Senna is the product of wild plants of *Cassia acutifolia*, growing in El Hejaz (a country bordering the Red Sea opposite Egypt and below Syria) and in the Anglo-Egyptian Sudan, and to a lesser extent of plants which have recently been cultivated in India. Some of the Sudan Senna is claimed to be worthless and only employed to adulterate the good supply from El Hejaz. The leaves are now usually gathered by the

natives of El Hejaz and the Sudan during the winter months. They either take hold of the bushes with both hands and pull them off, allowing them to drop to the ground or cut down the bushes, allow them to dry in the sun and later strip off the leaves. The latter practice is followed by the Bedouins in the country between Suakin and Kassala. After being completely dried, they are placed in hampers made of palm leaves. Each hamper holds  $2\frac{1}{4}$  Kentars or 225 pounds. Three of those are placed on each camel's back and carried to

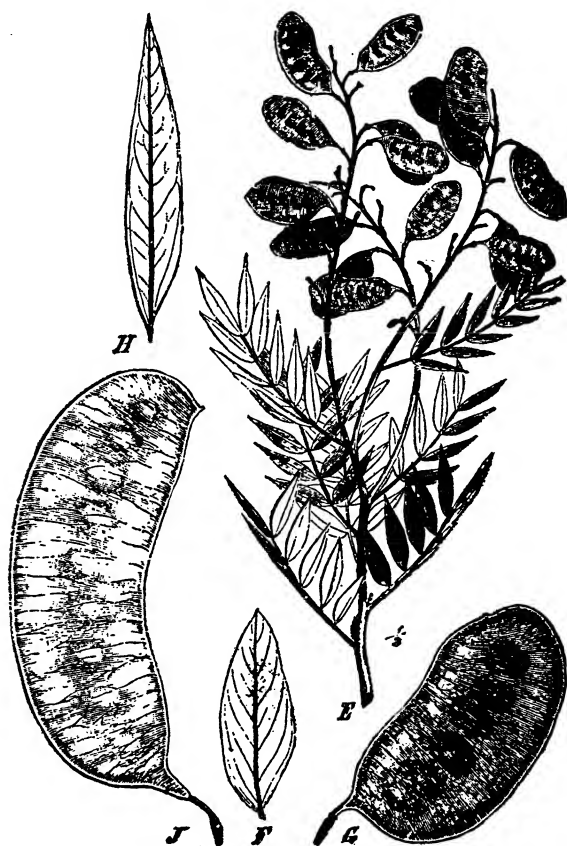


FIG. 224.—*Cassia acutifolia*: E, leaf and fruiting branch; F, a leaflet; G, a pod. *Cassia angustifolia*: H, a leaflet; J, a pod. (From Kramer's "Scientific and Applied Pharmacognosy," after Taubert.)

Port Sudan whence it is conveyed either to Port Said, Cairo, or Alexandria. Here it is cleaned and graded into whole leaf, half leaf and siftings. Cairo is the leading market for Alexandria Senna. Thence about 75 per cent. of that reaching this country is shipped direct, the other 25 per cent. comes indirectly through London. Alexandria Senna is received in large bales packed loosely.

Indian Senna is the product of cultivated plants of *Cassia angustifolia* grown in southern India (Tinnevely Senna) or of plants growing in Northern India and the Anglo-Egyptian Sudan. The leaves are collected, dried in the sun and

packed in bags for shipment. The Tinnevely Senna is the best grade of Indian Senna. It is carefully collected from cultivated plants and consists of leaflets of excellent green color, free from admixture with stems or pods or other extraneous matter. This is exported from Tuticorin, Madras and Calcutta. Inferior grades of Indian Senna have been offered on the market. These are collected, dried and garbled with less care and contain discolored leaflets, legumes, etc.

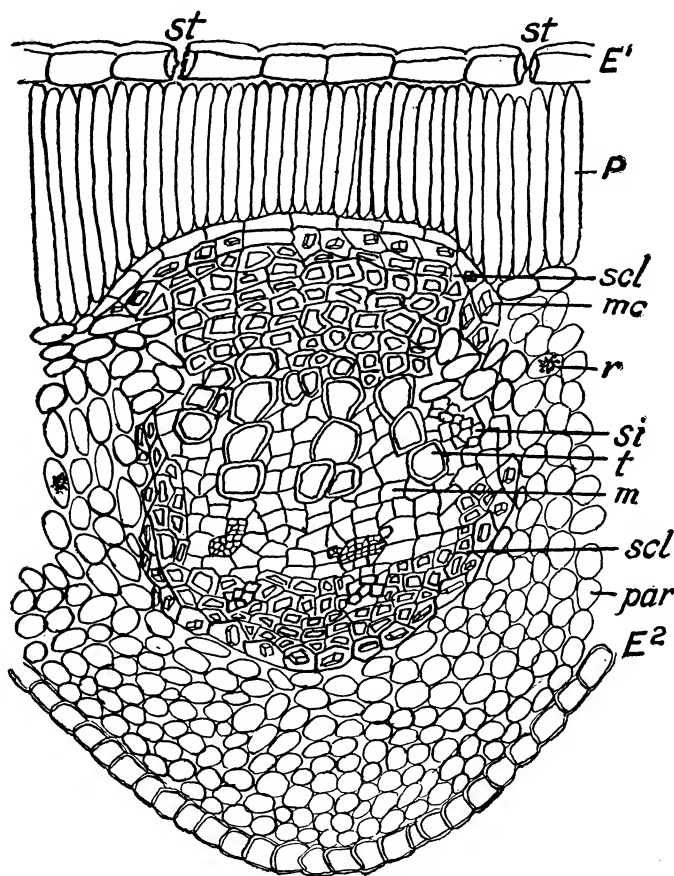


FIG. 225.—Indian Senna. Transverse section through midrib of leaflet, showing upper epidermis ( $E^1$ ); lower epidermis ( $E^2$ ); sunken stomata ( $st$ ); palisade parenchyma ( $P$ ); parenchyma ( $par$ ); sclerenchyma fibers in pericycle ( $scl$ ); tracheae ( $t$ ); sieve tissue ( $st$ ); monoclinic prisms ( $mc$ ) and rosette aggregates ( $r$ ) of calcium oxalate.

Tinnevely Senna is shipped to United States direct from Tuticorin, Madras and Calcutta, India. The product arrives in bales packed under pressure and burlap covered. Within recent years it has been cultivated with success in California and this state produces some of the present supply.

Arabian Senna, is collected from wild plants of *C. angustifolia* which thrive in Southern Arabia. This drug is shipped in the crude state from Hodeida to Port Sudan and thence carried by rail to Cairo where it is garbled and graded. At Cairo it is sometimes mixed with Alexandria Senna and



exported under the latter name. Some of this mixture has occurred frequently on the American market under the name of "Alexandria Senna."

Senna Pods, representing the dried ripe fruits of the *C. acutifolia* and *C. angustifolia* are also imported as a separate article as are also Senna Siftings. The latter frequently contain an excess of sand.

**Description.**—**Alexandria Senna** occurs as a mixture of entire and broken leaflets, pods and frequently stalks of the compound leaves. Leaflets short petiolate, with petiole up to 1 mm. in length; lamina inequilaterally lanceolate or lance-ovate, from 2 to 2.5 cm. rarely up to 4 cm. in length and from 6 to 10 mm. in breadth, its apex acute or mucronate, margin entire, base unequal, upper surface pale green nearly smooth; under surface grayish-green, with appressed hairs and showing prominent midrib; odor characteristic; taste mucilaginous and bitter. Pods few, broadly elliptical, somewhat reniform, thin and membranous and containing 6 to 7 seeds. (See Fig. 224.)

**Indian Senna** occurs as entire leaflets or as a mixture of entire and broken leaflets occasionally admixed with portions of compound leaves and pods. Leaflets short petiolate, with petiole up to 2 mm. long; lamina inequilaterally lance ovate, from 2 to 5 cm. in length and from 6 to 15 mm. in breadth, its apex broadly acute, margin entire, base unequal, upper surface yellowish-green and glabrous, lower surface pale yellowish-green, slightly hairy, midrib and veins elevated; odor and taste resembling Alexandria Senna. Pods few, more narrowly elliptical and reniform than those of Alexandria Senna and usually containing 8 seeds. (See Fig. 224.)

**Tinnevely Senna** occurs as usually unbroken leaflets, otherwise resembling Indian Senna except for the absence of pods, midribs and discolored leaflets.

**Histology.**—Transverse sections made through the **lamina** of an Indian Senna leaflet **outside of the midrib** show the following structural peculiarities. (Note: Leaflets should be kept in a moist chamber until supple before sectioning. Sections should be mounted in chloral hydrate for examination.)

1. *Upper epidermis* with prominent cuticle possessing broadly elliptical stomata that are sunken below its surface level, and relatively few non-glandular, 1-celled, conical, often curved, appressed hairs with papillose walls.

2. *Palisade Parenchyma* of a single layer of elongated, narrow, columnar cells containing chloroplastids.

3. *Spongy Parenchyma* consisting of rather loosely arranged, rounded cells, some of which contain rosette aggregates or 4- to 6-sided prisms of calcium oxalate, others, chloroplastids. Through this region course the bundles of the smaller veins.

4. *Palisade Parenchyma* of a single layer of columnar cells which differ from the upper palisade layer in being shorter and wavy-walled.

5. *Lower epidermis* with prominent cuticle and possessing sunken stomata. Both epidermises show a few outgrowths in the form of one-celled, papillose, straight to slightly curved, non-glandular hairs from 100 to 350 $\mu$  in length. Each of these, when observed, has its base wedged between adjacent epidermal cells.

Transverse sections cut through the **midrib of the lamina** show a fan-shaped group of collateral bundles in the center, xylem being uppermost, phloem beneath. Both above and below the group of bundles occurs an arc of thick-walled lignified pericyclic fibers, somewhat ovate in shape above and crescent shaped below. On the outer surface of each arc of fibers is a layer of cells, most of which contain 6- to 8-sided prisms of calcium oxalate. These are

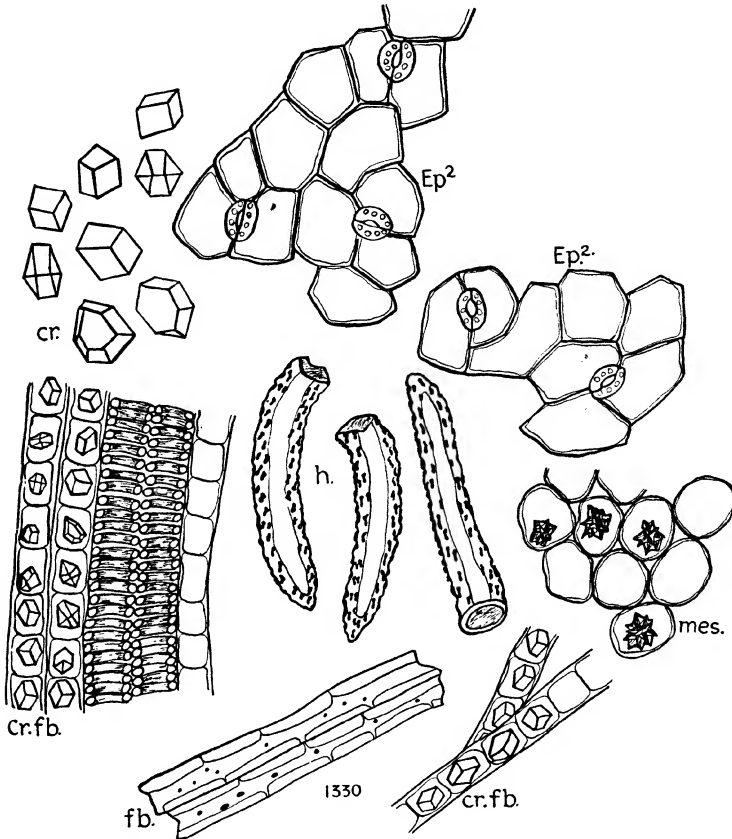


FIG. 226.—Powdered Alexandria Senna. *cr.*, monoclinic prisms of calcium oxalate; *Ep²*, fragments of both epidermises showing stomatal apparatuses with 2 and 3 neighbor cells; *h.*, unicellular, papillose, non-glandular hairs; *cr.fb.*, crystal fibers, those on the right adherent to vein bundle; *fb.*, portions of pericyclic fibers; *mes.*, mesophyll parenchyma containing rosette aggregates of calcium oxalate. (Drawing by Izzo.)

found to be the cells of crystal fibers when longitudinal sections are examined. Separating the upper layer of crystal fibers from the upper epidermis is a layer of small cells and finally a layer of palisade cells. Between the lower arc of crystal fibers and the lower epidermis occur several layers of parenchyma shading off into collenchyma. (See Fig. 225.)

Longitudinal sections cut through the center of the midrib show the lengthwise aspect of the elements. The tracheæ are spiral, annular and pitted. The

pericyclic fibers are elongated, narrow, thick-walled with tapered ends spliced over each other and showing oblique slit-like pores. A crystal fiber is just outside of each group of these. The upper epidermis is readily distinguished from the lower by locating the layer of palisade cells directly beneath it.

Surface sections of both upper and lower epidermis exhibit polygonal epidermal cells amongst which will be noted broadly elliptical stomata, each of which has 2 unequal neighboring cells parallel to its longer axis; occasionally a third neighboring cell at the end of the stoma is present. Unicellular papillose, pointed, non-glandular hairs and the rounded scars of the bases of these will also be observed. (See Fig. 226.)

Fragments of Senna show a red coloration when mounted in alkaline solutions.

**Powdered Drug.**—Powdered Indian Senna is dusky greenish-yellow to light olive brown. Calcium oxalate in rosette aggregates, from 9 to 20 $\mu$  in diameter, and in prisms 12 to 15 $\mu$  in length, usually in crystal fibers that adhere to groups of thick-walled sclerenchyma fibers of the pericycle; few unicellular, non-glandular, straight or curved hairs or fragments thereof with thick, papillose walls; fragments of epidermis, some of which show elliptical stomata with two unequal, parallel neighboring cells or occasionally a third neighboring cell; spiral, annular and pitted tracheæ.

Powdered Alexandria Senna is light green and differs from powdered Indian Senna mainly by showing more numerous hairs and more stomatal apparatuses accompanied by 3 neighboring cells.

**Constituents.**—The glycosides *sennoside A* and *sennoside B* (Stoll et al. 1941), believed to be the chief laxative principles, the anthraquinone derivatives *aloe-emodin* and *rhein*, occurring free and in combination as glycosides (Tutin, 1913); the yellow coloring matters kaempferol, kaempferin and isorhamnetin, a phytosterol glycoside, myricyl-alcohol, mucilage, resin, starch, calcium oxalate, etc.

**Use.**—Senna leaflets and pods are extensively used as a purgative. The purgative action is claimed to be due to the irritating effect of the anthraquinone derivatives upon the muscles of the colon, producing increased peristalsis.

**Average Dose.**—2 Gm. (30 grains).

**Preparations.**—In U.S.P.—Senna Fluidextract, 2 cc. (30 minims); Senna Syrup (from Fldext.), 8 cc. (2 fl. dr.). In N.F.—Compound Senna Powder (Compound Licorice Powder), 4 Gm. (1 dr.).

**Adulterants.**—1. The leaflets and pods of *Tephrosia appolinea* DC. (Fam. Leguminosæ) a plant indigenous to Egypt. The leaflets of this plant are obovate or obcordate in outline, have parallel veins of the first order, frequently show emarginate apex and are smaller than the average Senna leaflet. The pods are cylindrical up to 3 cm. long and about 3 mm. in breadth. Occasionally found in Alexandria Senna.

2. Argel Leaves. The leaves of *Solenostemma Argel* Hayne (Fam. Asclepiadaceæ) have been admixed with Alexandria Senna. They are short petiolate, lanceolate, coriaceous, with entire curved or curled margins, equal base, acute

apex, pubescent and pinnately veined. The midrib alone is distinct, the lateral veins being indistinct. The non-glandular hairs are uniseriate and 3- to 4-celled.

3. Dog Senna. The leaflets of *Cassia obovata* Colladon are broadly obovate, mucronate, from 12 to 22 mm. in length and about half as broad.

4. Arabian or Bombay Senna. (See p. 461.) These leaflets are elongate lanceolate in outline, averagely longer and narrower than those of Alexandria Senna and are often partly discolored.

5. Coriaria Leaves. The leaves of *Coriaria myrtifolia* Linné (Fam. *Coriariaceæ*), a Mediterranean shrub, are ovate to ovate-lanceolate, 3 nerved, coriaceous and glabrous. They have been cut into segments and mixed with cut Alexandria Senna. For details of histology, see under *Majorana*.

**Allied Drug.**—**Maryland Senna**, also known as American Senna, consists of the dried leaflets of *Cassia marilandica* L., a perennial herb, native to eastern U. S. where it occurs in swampy places from Mass. to Ohio and Tenn. and N. C. The leaflets are lanceolate to oblong-lanceolate with entire margin, mucronate or obtuse apex, and rounded base; dull green above, yellowish-green to greenish-yellow beneath. They are stated to contain *anthraquinone principles* but in smaller amounts than found in Egyptian and Indian Sennas. Used for the same purposes as the official Senna and formerly official in the U.S.P.

#### SENNA FRUIT (SENNÆ FRUCTUS)

**Synonyms.**—Senna Pods; *Ger.* Sennesbälge; *Fr.* Follicules de Séné.

**Botanical Origin.**—*Cassia acutifolia* Delile (Alexandrian Senna pods) and *Cassia angustifolia* Vahl. (Indian Senna pods).

**Part Used.**—The dried, ripe fruits.

**Description.**—Fruits greenish-brown to brown, broadly oblong, flattened legumes, rounded on ends and slightly mucronate at summit from the remains of the style, the latter being distinct in the Tinnevely but not in the Alexandrian variety, from 3.5 to 7 cm. in length and 2 to 2.5 cm. in width, each containing 5 to 8 grayish-green, hard, obovate-cuneate seeds. (See Fig. 224.)

**Constituents.**—From 1.3 to 1.4 per cent. of anthraquinones, and other constituents similar to senna leaves.

**Use.**—Purgative, and claimed to be less griping than the leaves.

**Dose.**—2 Gm. (30 grains).

#### SCOPARIUS (SCOPARIUS)

**Synonyms.**—Broom Tops, Irish or Scotch Broom, Broom; *Ger.* Besenginster; *Fr.* Genêt à balais.

**Botanical Origin.**—*Cytisus scoparius* (Linné) Link.

**Part Used.**—The dried tops.

**Purity Rubric.**—Not more than 5 per cent. of stems over 3 mm. in diameter and not more than 2 per cent. of other foreign organic matter.

**Habitat.**—Europe and Western Asia. Naturalized in the United States.

**Plant.**—A shrub growing to the height of 1 to 2.4 m., with numerous 5-angled, green, flexible branches bearing trifoliate leaves with sessile upper leaflets.

The inflorescences appear from May to June as racemes of bright yellow papilionaceous flowers. The fruit is a compressed legume containing numerous seeds.

**Production and Commerce.**—The younger green, flexible tops are gathered before the flowering of the plant and dried. While small amounts of the drug are gathered in the Pacific Northwest and in the Cape Cod district, most of the

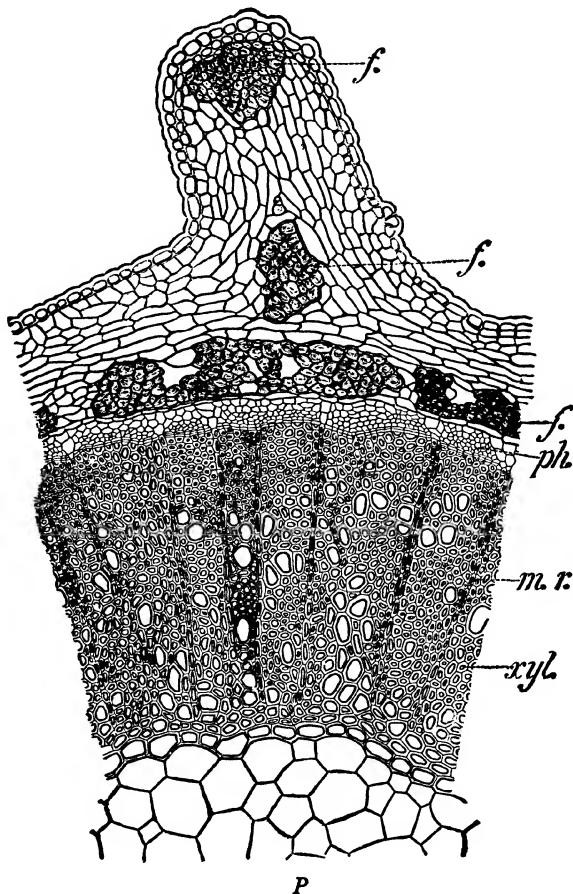


FIG. 227.—*Scoparius*. Transverse section of young stem.  $\times 100$ . *f.*, sclerenchyma fibers; *m. r.*, medullary ray; *ph.*, phloem; *xyl.*, xylem; *p.*, pith. (After Greenish.)

commercial article is collected in Great Britain and Southern Europe. The imported article is largely shipped to the U. S. A. from London and Marseilles in burlap bags or bundles.

**Description.**—The drug occurs either in the form of thin, flexible, branched, pentangular twigs, 2 to 3 mm. in thickness or as cut segments of these; externally dark-green, nearly smooth, with numerous reddish-brown cork patches; fracture short-fibrous, that of thicker pieces being tough and splintery; internally

yellowish; upper leaves sessile, often absent in the drug; odor slight, peculiar on bruising; taste bitter and disagreeable.

**Histology.**—Transverse sections made through the young portion of the twig exhibit an angular outline and the following peculiarities:

1. *Epidermis* of oblong and square cells with thick outer cuticle.
2. *Cortex* of several layers of cortical parenchyma cells, at intervals extending into the wings. It will be observed that 2 groups of thick-walled sclerenchyma fibers occur in each wing region of cortex. Between the group nearest the epidermis and the epidermis itself occur one or two layers of collenchyma cells.
3. *Pericycle*, containing an interrupted band of thick-walled, lignified pericyclic fibers.
4. A circle of compactly arranged *open-collateral bundles*, separated by narrow medullary rays. Each bundle exhibits a narrow phloem consisting of soft bast, a cambium, and a comparatively broad xylem of numerous wood fibers and spiral tracheæ.
5. *Pith*, a central zone of large, more or less polygonal, thin-walled cells.

**Powdered Drug.**—Dark green to brownish-green. Fragments of epidermis in surface view showing polygonal cells and small broadly elliptical stomata, each surrounded by small neighboring cells; non-glandular trichomes, thick walled, unicellular and papillated; fragments containing annular, but mostly spiral or double spiral tracheæ and tracheids; fragments of sclerenchyma fibers with simple pores; pollen grains football-shaped; fragments of parenchyma of pith and cortex; few starch grains up to  $20\mu$  in diameter.

**Constituents.**—The liquid alkaloid, *sparteine*; the yellow flavone, *scoparin*; the volatile alkaloid, *genisteine*; tannin, etc.

**Uses.**—Scoparius has been employed as a diuretic in dropsy in the form of the unofficial infusion. It is the source of sparteine.

**Average Dose.**—1 Gm. (15 grains).

**Adulterant.**—The tops of *Osyris alba* Linné (Fam. *Santalaceæ*) which have a many striated stem and white wood.

**Sparteine Sulfate (Sparteinae Sulfas) N.F.**,  $C_{15}H_{26}N_2 \cdot H_2SO_4 \cdot 5H_2O$ , occurs in colorless rhombohedral crystals or in a white powder. It is without odor and possesses a slightly saline, somewhat bitter taste. It is hygroscopic, affected by light and should be preserved in tight, light-resistant containers. It is used as a cardiac depressant to quiet an overactive heart, in functional palpitation, tachycardia, etc. Av. dose, 30 mg. ( $\frac{1}{2}$  grain).

#### KINO N.F. (KINO)

**Synonyms.**—Gum Kino, Malabar-, East India-, Madras-, or Cochin-Kino; *Fr.* Kino de l'Inde; *Ger.* Kino.

**Botanical Origin.**—*Pterocarpus Marsupium* Roxburgh.

**Part Used.**—The dried juice, obtained from the trunk.

**Purity Rubric.**—Not less than 60 per cent. of alcohol-soluble extractive and not less than 75 per cent. of water-soluble extractive.

**Habitat.**—Forests of Eastern India.

**Plant.**—A large timber tree with alternate, imparipinnate leaves having 5–7 emarginate leaflets, pale yellow flowers and an orbicular indehiscent legume containing a single seed.

**Production and Commerce.**—The phloem region of the bark of this tree has been found to contain a large number of tubular cells arranged in axial rows. These cells contain a red astringent fluid which exudes to the surface when the bark is wounded. Kino is collected by the natives who make vertical incisions in the bark of the trunk with oblique lateral ones running into them. The red juice that flows is collected in cups or other receptacles, evaporated to the consistency of a hard mass in the sun, and broken up into small fragments. It is packed in wooden boxes and shipped to the U. S. A. either direct from Bombay, India or through London.

**Description.**—In small, brittle, angular fragments, usually less than 10 mm. in diameter, varying in color from reddish-black to dusky brown; inodorous; taste very astringent; when masticated it colors the saliva pink. An aqueous solution of Kino gives a yellowish-green precipitate with ferric chloride T.S. and a brown or orange color with an aqueous alkaline solution.

**Powdered Drug.**—Dusky reddish-brown to dark brown; in angular fragments, with glass like conchoidal surfaces, the thinner pieces translucent, red to yellowish-orange; when mounted in water and examined under a microscope, the fragments become rounded and gradually disintegrate, leaving lighter colored, granular particles among which are rod-shaped bacteria and a very few cellular fragments; in an alcohol mount, the color of the fragments deepens, the translucency increases, and the sharp angular outlines are visible while solution is taking place.

**Constituents.**—About 75 per cent. of *kinotannic acid* which gives a greenish color with ferric salts; a colorless non-astringent substance called kinoin; a phlobaphene called kino red, pyrocatechin, gallic acid, an enzyme claimed to induce gelatinization of kino-tannic acid in unheated liquid preparations, gum, etc.

**Use.**—Astringent in diarrhea.

**Average Dose.**—0.5 Gm. ( $7\frac{1}{2}$  grains).

**Preparation.**—Kino Tincture, N.F. 2 cc. (30 minims).

#### CASSIA FISTULA (CASSIA FISTULA)

**Synonyms.**—Purging Cassia, Cassia Pods, Indian Laburnum, Cassia Stick Tree; *Fr.* Casse officinale; *Ger.* Purgiercassie.

**Botanical Origin.**—*Cassia fistula* L. (*Cathartocarpus Fistula* (Linné) Persoon.)

**Part Used.**—The dried fruit.

**Habitat.**—India. Naturalized in Africa, West Indies and South America.

**Plant.**—A tree attaining a height of about 15 m. with gray bark and paripinnate leaves with 3 to 7 pairs of ovate leaflets and racemes of yellow flowers that appear from May to June. The fruit is an elongated, reddish-brown to black, cylindrical loment with numerous compartments, each containing a

flattened, ovoid, shiny, reddish-brown seed embedded in a brownish, hardened pulp.

**Production and Commerce.**—The fruits are gathered in India, the East Indies, West Indies and South America, packed in burlap bundles or bags (East Indian and Indian) or in cylindrical baskets made of plaited cane (West Indian). The drug is imported from Calcutta, Karachi, London, Rotterdam

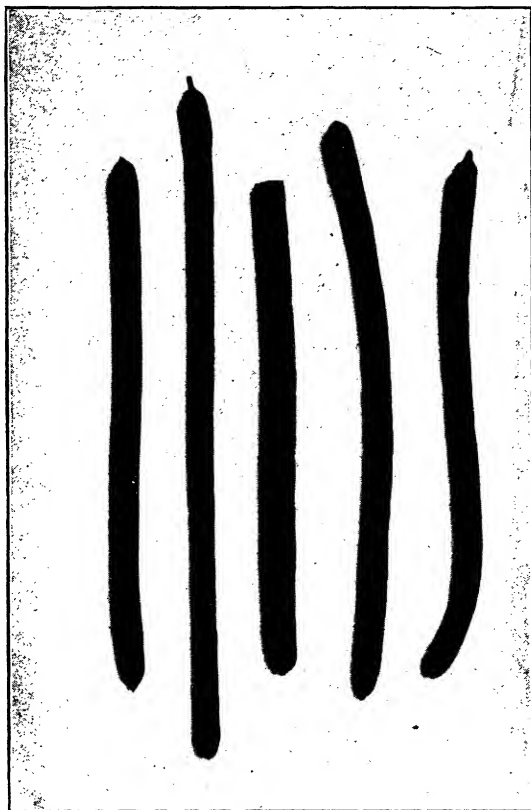


FIG. 228.—*Cassia Fistula*,  $\times \frac{1}{4}$ . (Photograph by Stoneback.)

and Hamburg, the West Indies and South America. The fruits should be collected when ripe and carefully dried. The best fruits are those which do not rattle when shaken. These possess the most pulp.

**Description.**—Purging Cassia occurs as entire, cylindrical or broken loment, from 25 to 65 cm. in length and 18 to 25 mm. in diameter; externally reddish-brown to nearly black, showing a constriction at the base and frequently an attached portion of the pedicel, also a longitudinal groove on one side and a smooth line or slight ridge on the other which indicate the sutures; internally the cavity is divided into numerous compartments, each containing a reddish-brown, shiny, flattened, ovoid seed embedded in a blackish-brown sweet pulp; odor prune-like.



**Constituents.**—From 25 to 30 per cent. of pulp which contains up to 60 per cent. of sugar, also mucilage, proteins, volatile oil, about 1 per cent. of *anthraquinone substance* (Wasicky), etc.

**Use.**—As a laxative.

**Average Dose.**—4 Gm. (60 grains).

#### TAMARINDUS (TAMARIND)

**Synonyms.**—Tamarind Pulp; *Ger.* Tamarinden; *Fr.* Tamarinier.

**Botanical Origin.**—*Tamarindus indica* Linné. (Sub. fam. *Caesalpinaceæ*).

**Part Used.**—The partially dried ripe fruit, deprived of the brittle outer portion of the pericarp and preserved in sugar or hot syrup.

**Habitat.**—Africa. Cultivated in India and the East Indies.

**Plant.**—A large spreading tree with alternate paripinnate leaves, each with 8 to 10 pairs of leaflets, and lateral racemes of yellow flowers. The fruit is a flattened indehiscent legume with a brownish brittle endocarp, succulent, acid and stringy mesocarp, and leathery endocarp, the latter enclosing each seed.

**Production and Commerce.**—The plants are grown in the West Indies, East Indies and Egypt. There are two important commercial varieties, West Indian and East Indian. West Indian Tamarind is prepared by first separating the epicarp and then packing the fruits in barrels with hot syrup as a preservative. It occurs as light reddish-brown to dark brown or black brown masses of preserved pulp containing seeds. East Indian or Black Tamarind occurs in black masses or cakes which are prepared by pressing together pulp, shells and seeds and sometimes preserving with salt. It is more acid in taste and of a darker color than the West Indian article.

**Description.**—A pulpy mass of a light reddish-brown color, changing with age to a dark brown; or black (E. Indian); containing some branching fibers and numerous reddish-brown, smooth, oblong or quadrangular, compressed seeds, each enclosed in a tough membrane (endocarp). Odor distinct; taste sweet and agreeably acid.

**Constituents.**—*Organic acids* including tartaric acid, lactic acid, malic acid, citric acid (12 to 15 per cent.); *potassium bitartrate*, pectin, tannin, invert sugar, etc.

**Uses.**—Laxative and refrigerant and in preparation of confection of senna.

**Average Dose.**—15 Gm. (4 drachms).

#### CHRYSAROBIN U.S.P. (CHRYSAROBINUM)

**Synonyms.**—Acidum Chrysophanicum Crudum, Araroba Depurata; *Ger.* Chrysarobinum; *Fr.* Araroba Purifié.

**Botanical Origin.**—*Andira Araroba* Aguiar [*Vouacapoua Araroba* (Aguiar) Druce.]

**Part Used.**—A mixture of neutral principles obtained from Goa powder, a substance deposited in the wood of *Andira Araroba*.

**Habitat.**—Damp forests of Brazil.

**Plant.**—A large tree.

**Production and Commerce.**—Goa powder or Araroba from which Chrysarobin is obtained occurs as a yellowish powder in longitudinal fissures in the wood of the trunk of the tree. It represents a pathological product due to the breaking down of the walls and changes in the contents of the wood tissues, the cause of which is unknown. The trees are cut down and their trunks sawed into segments, the latter split lengthwise, and the yellowish Goa powder scraped out along with some splinters of wood and exported from Bahia, Brazil, to Europe. It is later purified by sifting it free from wood fragments, drying and powdering, the purified Goa powder being yellowish-brown to brown, becoming dark brown to brownish-purple after exposure to air for some time. From this Goa powder Chrysarobin is obtained by boiling it with benzene, filtering, cooling the hot benzene solution and collecting the deposit which consists of an orange-yellow crystalline powder.

**Description.**—A brown to orange-yellow microcrystalline powder, tasteless, odorless and irritating to the mucous membrane; very slightly soluble in water, soluble in hot chloroform and benzene, almost entirely soluble in hot alcohol. It forms deep red solutions with solutions of alkali hydroxides and with sulfuric acid.

**Identity Test.**—When 2 mg. of Chrysarobin are mixed with 2 drops of fuming nitric acid the mixture is red brown; upon adding a few drops of ammonia T.S., the color changes to violet red. By this test, chrysophanic acid gives a yellow color.

**Uses.**—Parasiticide in skin diseases, frequently in the form of the official ointment.

**Preparation.**—Chrysarobin Ointment, U.S.P.

#### DERRIS (DERRIS)

**Synonym.**—Tuba Root, East Indian Fish Poison.

**Botanical Origin.**—*Derris elliptica* (Roxb.) Bentham and *Derris malaccensis* Prain.

**Parts Used.**—The dried subterranean stems and roots.

**Habitat.**—Malaya and East Indies.

**Plants.**—*Derris elliptica*, known to natives of the Malay Archipelago as "Aker-tuba" and "Tuba Puteh," is a large climbing shrub with purplish-brown stems having scattered circular to elliptical lenticels and black, closely warted branches. Its leaves are alternate, grayish-green, imparipinnate, up to 15 inches long with 9 to 13 leaflets. The leaflets are oblong, oblong-lanceolate to ob-lanceolate, slightly hairy to glabrous on the upper surface; rusty-tomentose on the lower surface, cuspidate to mucronate at apex, cuneate at base, with entire margin, short petiolate, pinnate-reticulate in venation, the veins of the first order being paired below and alternate toward the summit, the midrib and veins being most prominent on the lower surface, the petiolule rusty-pubescent. The flowers are papilionaceous and occur in axillary compound racemes, the rachis of which exhibits distinct nodes from which pedicels arise, each of the pedicels producing from one to three secondary pedicels, the latter ending with

a flower. Each flower consists of a campanulate calyx, a papilionaceous corolla having an orbicular standard which is silky externally (most diagnostic feature) and shows two appendicular callosities at its base, 10 monadelphous stamens, a monocarpellary pistil with a simple style and villose ovary. The fruit is a flattened, elliptical legume, narrowly winged along the sutures, from 1 to 3.5 inches in length and containing one to four seeds.

**Production and Commerce.**—Derris is cultivated for the market in the Federated Malay States, in Johore, at Sarawak, Borneo, in the Philippines, in India, Ceylon, Belgian Congo and Honduras. It is propagated by stem cuttings about 18 in. long planted in clayey loam containing a fair amount of sand. After rooting in a nursery bed, the cuttings are transferred to the field and set 3 ft. apart in rows 3 ft. apart. The rhizomes and roots are harvested after the second year of growth, washed and carefully dried for about 10 days, spread out in open sheds. The yield is about 1000 pounds per acre. Derris has been imported into this country from the Netherlands Indies, Philippine Islands, Belgian Congo, from British Malaya, Haiti, India and the United Kingdom.

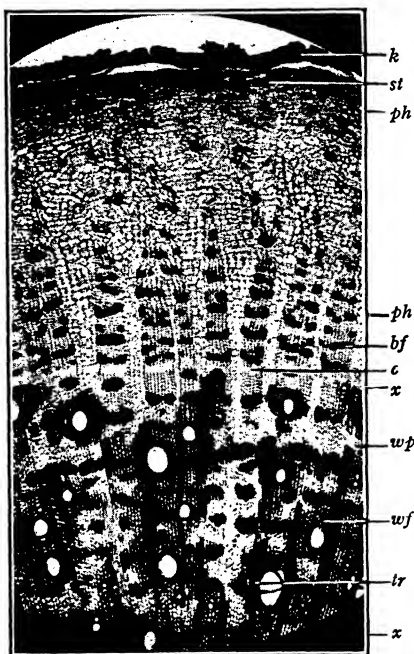


FIG. 229.—*Derris elliptica*. Transverse section of rhizome.  $\times 28$ . *k*, cork; *st*, stone cells in cortex; *ph*, phloem; *b.f.*, bast fibers; *c*, cambium; *wp*, wood parenchyma; *wf*, wood fibers; *tr*, trachea; *x*, xylem. The broken, dark radiate bands in the xylem represent medullary rays. The light portions of these are non-lignified.

**Description.**—Subterranean stem and roots attached or separate or in segments of varying length. Rhizome oblique, sometimes tortuous and branched, usually in segments 2 cm. to 15 cm. in length and 8 mm. to 25 mm. in thickness; externally brown, longitudinally wrinkled and showing numerous circular lenticels and transverse fissures, frequently with a number of roots attached to its posterior and under surfaces; fracture unbreakable in short, thick pieces, tough-fibrous in long pieces; internally reddish-brown to light brown, exhibiting a bark up to 2 mm. in width, a comparatively broad wood and a small central pith, the latter often hollow in longitudinally cut segments. Roots elongated conical and

frequently in part adventitious from truncated stumps of the rhizomes of cultivated plants, often branched, up to 60 cm. or more in length and 8 mm. in thickness; externally brown, purplish-brown or purplish-gray brown, longitudinally wrinkled with scattered warts; internally bark brown, up to about 0.5 mm. in thickness, wood buff; fracture short-fibrous,

hazel-switch like, the bark readily separating from the wood and itself separable into layers; odor characteristically aromatic; taste sweet, somewhat licorice like, followed in time by a sensation of numbness.

**Histology of Rhizome (*Derris elliptica*).**—In cross-section, the *cork* consists of up to 12 layers of tabular cells with more or less lignified walls. The individual cells are up to  $56.02\mu$  in length and  $14.18\mu$  in width. Many of them contain a brownish to reddish-brown amorphous content.

The *cork cambium* (phellogen) consists of thin-walled meristematic cells. The *cortex* is extremely narrow, averagely about three layers of cells in breadth, and composed of tangentially-elongated starch parenchyma and scattered *resin cells* with yellowish-brown content.

The *pericycle* is composed of a narrow zone of tangentially-elongated starch parenchyma and resin cells through the outermost region of which is an interrupted arc of stone cells of variable shapes and sizes. The stone cells occur isolated and in tangentially-stretched bands. Occasionally a rhombohedral crystal can be seen in the lumen of some of these.

The *phloem* is very broad and composed of elongated, conical phloem patches separated by wedge-shaped phloem rays, the latter containing starch grains and resin. Each phloem patch is composed of alternating zones of hard and soft bast, the bast fiber groups being usually more or less surrounded by crystal fibers whose cells contain rhombohedra of calcium oxalate. The individual bast fibers are thick walled, rounded-polygonal to polygonal and vary considerably in degree of lignification, when examined in phloroglucin-HCl.

The *cambium* is broad and conspicuous for its small, thin-walled cells with protoplasmic contents.

The *xylem* is about twice the width of the phloem. It is composed of numerous, radially-elongated xylem patches separated by starch- and resin-containing medullary rays. Each xylem patch is composed of a matrix of wood parenchyma whose cells are largely filled with starch grains or resin. In this matrix are imbedded numerous tiers of wood fibers of varying lignification and single, large tracheæ or groups of from two to more rarely five or six of these.

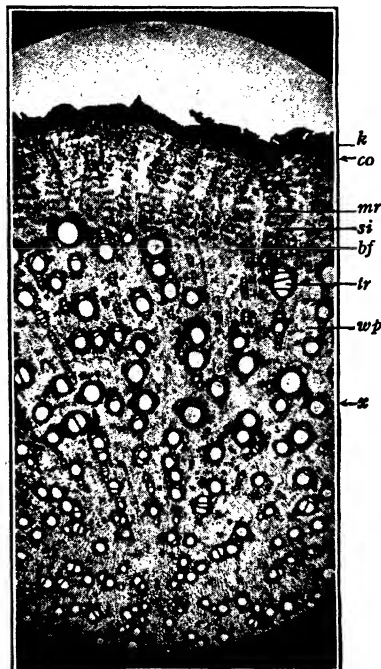


FIG. 230. —*Derris malaccensis* root. Photomicrograph of transverse section of representative portion.  $\times 18$ . *k*, cork; *mr*, phloem medullary ray; *st*, sieve tissue; *bf*, bast fibers; *tr*, trachea; *wp*, wood parenchyma; *co*, secondary cortex containing stone cells; *x*, xylem.

The width of these tracheæ is usually up to  $129.5\mu$  and serves as a diagnostic factor. The wood fibers vary greatly in extent of lignification and thickness of their walls.

The wood fiber groups are more or less surrounded with crystal fibers containing rhombohedra of calcium oxalate. The xylem rays are composed of radially-elongated, parenchymatous cells containing starch and in numerous instances resin. Their walls vary in respect to lignification, some of the cells being non-lignified, others slightly lignified, most lignified. The radial stretches of non-lignified portions of medullary rays in the xylem of *Derris*, give a broken appearance to the xylem rays in stained sections and, along with the non-lignified character of many areas of xylem cells, provide a striking anomaly.

*Radial-longitudinal sections* show the crystal fibers to best advantage. These are very numerous in both xylem and phloem, being adherent to bundles of sclerenchyma fibers. The tracheæ are characterized by having simple, slit-like to elliptical pits in their walls. Numerous tracheids with simple pits also occur in the xylem. The bast fibers in this kind of section are thick-walled, narrow lumened for the greater part, and possess pointed ends. Many pursue a wavy course. The stone cells in the pericycle are rounded, oblong, triangular, ovate, rhomboidal or irregular in shape, and possess broad lumina and prominent pore canals.

*Tangential-longitudinal sections* show the medullary rays to be from 1 to 7 cells in width. In water mounts the starch cells of the medullary rays appear white in sharp contrast to the yellowish-brown resin cells.

**Histology of Root.**—In general it may be said to bear a somewhat similar appearance to the rhizome when examined in all three types of sections discussed under the histology of that organ, differing mainly from it by its absence of pericycle, primary cortex and pith, the absence of stone cells in the outer region of the bark of *D. elliptica* and its narrower cambium. The root of *Derris malaccensis* possesses groups of stone cells in the secondary cortex.

**Powdered Derris.**—The powder here described was obtained by grinding the roots and rhizome of *D. elliptica*. The powdered drug is reddish-brown. It shows, when mounted in appropriate reagents, the following elements: Numerous fragments of bundles of non-lignified and of lignified, thick-walled sclerenchyma fibers with attached portions of crystal fibers containing rhombohedra of calcium oxalate, the rhombohedra being up to  $21.24\mu$  in diameter; numerous fragments of reddish-brown cork tissue, the cells of which frequently contain reddish-brown amorphous contents and appear polygonal to rectangular in shape, their walls being more or less lignified; numerous simple, pitted tracheæ and tracheids, the tracheæ having mainly slit-like pores and strongly lignified walls and being up to  $148.2\mu$  in diameter; numerous fragments of cortical and of wood parenchyma and medullary rays containing starch and resin; numerous starch grains, the latter being simple, 2- to 3-compound and occasionally in oval aggregates, the simple grains varying from spheroidal to spheroidal and beaked at one end, to plano-convex, elliptical and polygonal and measuring up to  $17.7\mu$  in diameter or length; stone cells relatively few with moderately thickened,

lignified walls, large lumen and usually distinct pore canals and occurring in a wide variety of shapes including elliptic, triangular, rectangular, polygonal, circular and irregular modifications of these. They are up to  $47\mu$  in length, their walls being up to  $4\mu$  in thickness.

**Constituents.**—About 8 per cent. of the active insecticidal principle called *rotenone* ( $C_{23}H_{22}O_6$ ); resins, starch, calcium oxalate, etc. Rotenone occurs in colorless, odorless, orthorhombic crystals melting at  $163^\circ\text{C}$ . Its solutions are strongly laevorotatory.

**Uses.**—As an insecticide either in the form of a fine powder (for dusting) or in preparations containing an extract of the drug. Rotenone is used in commercial insecticides such as fly sprays, greenhouse and horticultural sprays, and dusts, flea powders, etc., and for moth-proofing woolen clothing. Rotenone has also been found in *Derris chinensis*, *D. uliginosa*, *D. polyantha*, in *Lonchocarpus* spp., *Pachyrrhizus* sp. seeds, *Mundulea suberosa*, *Spatholobus Roxburghii*, *Millettia* spp. and in *Tephrosia virginiana*, *T. cinerea* and *T. latidens*, all members of the Leguminosæ Family.

**Allied Drugs.**—*Lonchocarpus* also called Cubé Root and Barbasco, consists of the dried roots of *Lonchocarpus nicoi* and allied species of *Lonchocarpus* (Fam. Leguminosæ) native to South America. The roots are elongated, conical, sometimes tortuous and branched, up to 33 cm. in length and up to about 30 mm. in width, externally yellowish-brown to light brown, longitudinally wrinkled and showing numerous narrow transverse lenticels and rootlet scars; fracture short and uneven, the fractured surface showing a light brown bark up to 2 mm. in width and a yellow porous wood; odor indistinct; taste somewhat sweet followed by a sensation of numbness in the mouth. It contains *rotenone*, *deguelin* (an isomer of rotenone), dehydrodegulin, etc. It is imported in large amounts from Brazil and used similarly to Derris as an insecticide and source of rotenone. The best sources of Cubé Rt. are *L. utilis* and *L. urucu*.

**Tephrosia**, commonly known as Devil's Shoe String, is the dried root of *Tephrosia virginiana* L. (Fam. Leguminosæ), a perennial herb, 1 to 2 ft. in height, with compound leaves bearing numerous narrowly elliptic leaflets, papilionaceous flowers of dull yellowish-white color with purple markings, and many seeded legumes up to 3 in. in length. It is native to the eastern United States, occurring most abundantly in the southern states. It contains *rotenone* and other constituents of insecticidal value

#### PISCIDIA (PISCIDIA)

**Synonyms.**—Jamaica Dogwood, Jamaica Fishfuddle Tree, Mulungu.

**Botanical Origin.**—*Piscidia piscipula* Sarg. (*P. Erythrina* Linné; *Ichthyomethia piscipula* Hitchcock).

**Part Used.**—The dried stem bark.

**Habitat.**—Tropical America (Jamaica, West Indies, northern South America, Mexico, southern Florida).

**Plant.**—A tree attaining a height of about 40 ft. having imparipinnate leaves with 7-11 oblong, ovate or elliptic leaflets with short articulate petiolules,

purplish white papilionaceous flowers and longitudinally 4-winged legume fruits up to 4 in. in length containing 6-8 black seeds.

**Commercial Source.**—Jamaica.

**Description.**—In flattened or transversely curved pieces from 5 to 30 cm. in length, up to about 8 cm. in width and up to 1.5 cm. in thickness; outer surface



FIG. 231.—*Piscidia piscipula* (L.) Sarg. Leafy branch of tree yielding Jamaica Dogwood bark.  $\times \frac{1}{2}$ .

varying from yellow through shades of brown to purplish, the younger bark with numerous scales of cork and oval lenticels, the older bark sometimes covered with whitish lichens, some pieces exhibiting circular projections or warts and a greenish phelloderm where cork is abraded; fracture short in outer bark, irregular and splintery in inner bark, some pieces exhibiting a pale yellow to bluish green fractured surface in the middle bark; inner surface longitudinally

striate, pale brown to purplish or blackish brown, areas on some pieces with closely set transverse striae visible under a hand lens; odor indistinct; taste acrid.

**Powdered Drug.**—Brownish gray. Numerous fragments of groups of sclerenchyma fibers, some with adhering crystal fibers and often with adherent, tangentially cut, spindle-shaped medullary rays; numerous monoclinic prisms of calcium oxalate up to  $35\mu$  in diameter, both isolated and within cells of crystal fibers; simple to 2- to 4-compound starch grains, the individual grains, spheroidal or plano- to angular-convex with distinct central hilum, and mostly up to  $8\mu$  in diameter; fragments of cork.

**Constituents.**—A substance called *piscidin* (Hart) which is stated to be a mixture of two glycosides (Freer and Clower, 1905), one crystallizing in colorless rectangular prisms ( $C_{23}H_{20}O_7$ ) melting at  $201^\circ C.$ , the second ( $C_{20}H_{16}O_6$ ) forming fine yellow needles melting at  $216^\circ C.$ ; piscidic acid found in aqueous extract forming acicular crystals, a crystalline monohydric alcohol belonging to the sterols, a saponin glucoside, starch, calcium oxalate, etc.

**Uses.**—Anodyne in neuralgia and pertussis, uterine sedative. The leaves, bark and twigs of the tree have long been used by the natives of Jamaica who throw them in the water to stupefy fish so that they can be readily caught.

**Average Dose.**—2 Gm. (30 grains).

**Preparation.**—Fluidextract of *Piscidia*, 2 cc. (30 minims).

#### PEANUT OIL U.S.P. (OLEUM ARACHIDIS)

**Synonyms.**—Arachis Oil, Ground-nut Oil; *Ger.* Erdnussöl; *Fr.* Huile d'arachide.

**Botanical Origin.**—Cultivated varieties of *Arachis hypogæa* Linné.

**Part Used.**—The fixed oil obtained by cold pressure from the peeled seeds.

**Habitat.**—Brazil.

**Plant.**—An annual plant with thick, angular, pubescent, branching stems which are prostrate in the running varieties or upright in the bushy varieties. Leaves paripinnate and usually with 2 pairs of subsessile, entire leaflets and elongated stipules. Flowers papilionaceous, axillary, orange-yellow, and of 2 kinds, sterile and fertile. Each fertile flower possesses a long slender calyx tube, bearing on its rim the calyx lobes, corolla and stamens, an ovary at the base of the calyx tube from which emanates a long filiform style which extends through the calyx tube terminating in a small stigma. After the fertilization of the ovules, the corolla and stamens fall off; then the peduncle elongates, carrying the flower with its developing ovary downward into the ground. There the ovary matures into the fruit called the "peanut." The fruit is an oblong, indehiscent, reticulated legume with 1 to 3, occasionally 4 or 5 exalbuminous seeds.

**Production and Commerce.**—The peanut is extensively cultivated in the southern United States, South and Central America, S. Europe, Africa and India as a food, oil and forage crop. In the United States, Virginia, the Carolinas and Tennessee have been the principal regions of culture. It thrives best



in sandy soil and south of the 36° latitude. The best known varieties grown in this country are the Virginia Bunch, Virginia Runner, Carolina, Spanish and Tennessee Red. The seeds ("nuts") of the Spanish and African varieties are smaller than those of the other types as well as richer in oil, yielding from 45 to 51 per cent. The fruits are shelled by machinery, the seed coats detached by brushing and blown off by air-blast. The kernels (embryos) are then crushed in the cold and the fixed oil collected as "cold expressed oil." The remainder of the oil is removed by hot expression and is of inferior grade. The oil is packaged in light resistant containers.

**Description.**—A colorless or pale yellow oily liquid with a bland taste and with or without a nutty odor, very slightly soluble in alcohol and miscible with ether and chloroform; sp. gr. 0.912 to 0.920; ref. ind. 1.4625 to 1.4645 at 20°C.

**Constituents.**—Oleic, linolic, palmitic, stearic, arachidic and lignoceric acids.

**Uses.**—In the preparation of Penicillin Injection in Oil and Wax, U.S.P.; as a substitute for olive oil when the latter is not available, in liniments, etc.

**By Products.**—**Peanut Shells** in the finely ground condition have been found as an adulterant in ground spices and drugs. The chief diagnostic elements are the peculiar T-shaped, halberd-shaped and unilateral toothed types of sclerenchyma fibers. **Peanut Skins**, representing the spermoderm and attached perisperm, represent a rich source of thiamine. **Peanut Cake**, representing the crushed kernels deprived of their fixed oil, is used as a cattle food.

#### MINOR LEGUMINOUS DRUGS

**Baptisia** or Wild Indigo is the dried root of *Baptisia tinctoria* (Linné) R. Brown, an erect, perennial, much branched herb with trifoliate leaves, racemes of bright yellow papilionaceous flowers and ovoid, bladder legumes native to eastern U. S. and Canada. It contains the alkaloid *cystine* and the glycosides *baptin* and *baptisin*. The powdered root has been used as an ingredient in tooth powders. An infusion has been used topically in treating foul ulcers, and the fluidextract was formerly used in the treatment of infectious fevers and pharyngitis. Av. dose, 1 Gm. (15 grains).

**Abrus** (Jequirity, Prayer Beads, Indian Liquorice, Crab's Eyes) is the seed of *Abrus precatorius* L., a creeping or climbing woody vine with pinnately compound leaves, rose or white flowers and bright scarlet red seeds, native to the tropics and occurring in Florida and the West Indies, Brazil and India. The seeds are ovoid, up to 8 mm. in length, smooth bright scarlet with a black spot near the hilum. They are extremely irritant when broken and ingested. They contain a toxalbumin called *abrin* which is fatal to animals in 0.01 mg. per kilo of body weight. *Abrin* is used in the form of a sterile solution (1:500,000) in chronic eye diseases, such as trachomatous pannus, also as jequiritol serum which is used in the treatment of poisoning by *Abrus* or *abrin*.

**Melilotus** or Yellow Melilot consists of the dried leaf and flowering top of *Melilotus officinalis* (Linné) Lamarck, a perennial herb native to Europe and naturalized in the U.S.A. It contains *coumarin*, volatile oil, melilotic acid, and *dicoumarin*. **Dicoumarin** or **Dicoumarol** has been found to diminish the clot-

ting power of the blood and has recently been used experimentally as an anti-coagulant in the treatment of thrombosis and embolism.

**Cascara Amarga** or Honduras Bark is the dried bark of *Sweetia panamensis* Benthams, a tree with imparipinnate leaves and panicles of white flowers native from S. Mexico to Panama. It contains the alkaloid called "sweetine" (St. Clair). It is a simple bitter. Av. dose, 1 Gm. (15 grains).

**Ceratonia** (Carob Bean), commonly known as St. John's Bread, is the dried fruit of *Ceratonia siliqua*, a tree native to eastern Mediterranean countries and cultivated throughout the Mediterranean section.

Carob Bean occurs as entire or broken loment; when entire, oblong, flattened on the sides, externally dark brown, lustrous with irregular longitudinal wrinkles and depressions, with both edges longitudinally grooved; fracture short and irregular; when cut lengthwise along the edges, it exhibits a row of transverse seed cavities each lined with a parchment-like membrane and each containing a single obovate, dark brown or red seed. The fruit flesh is dark brown to black and pleasantly sweet. It contains *sugars*, proteins, an *enzyme* named "*semi-urease*" (Wagenaar) which partially hydrolyzes urea to ammonium carbamate; tannin, etc. It is used as a nutrient and in the preparation of carob syrup and liquors. The roasted seeds have been used as an adulterant and substitute for coffee.

#### GERANIACEÆ (GERANIUM FAMILY)

Herbaceous, rarely semi-succulent, sub-shrubby plants. Stems cylindrical, often hairy or glandular hairy. Leaves alternate to opposite, stipulate; venation from pinnate to palmate, so leaf shape from ovate to pinnatifid to pinnatipartite to subpalmatifid to palmatipartite to compound palmate. Inflorescence either a dichesial or scorpioid cyme. Flowers regular, pentamerous (*Geranium*) to irregular pentamerous (*Pelargonium*); sepals five, aposepalous; petals five, apopetalous, varying in color from greenish-white or pink-red to scarlet, scarlet-crimson to crimson-purple; anthers ten or five, hypogynous or inserted into slightly developed hypogynous disc; pistil pentacarpellary, ovary five-celled with two, rarely one ovule in each cell, styles elongate, fused round a styler column of receptacle, then continued as a styler tip which splits into five stigmatic surfaces. Fruit a regma, rarely a simple capsule. Regma splits into five recurved carpels, each then dehiscing to set free two or one seeds. Seeds exalbuminous.

#### GERANIUM (GERANIUM) H.P.

**Synonyms.**—Cranesbill, Wild Geranium, Spotted Geranium, American Kino; *Ger. Fleckstorchschnabelwurz*; *Fr. Racine de Bec-de-Grue tacheté*.

**Botanical Origin.**—*Geranium maculatum* Linné.

**Part Used.**—The dried rhizome. The fresh rhizome (H.P.).

**Habitat.**—In rich woods of Canada and the United States.

**Plant.**—A perennial herb with long petioled, nearly orbicular, reniform or cordate, deeply 3 to 5 parted radical leaves. Its stem leaves are shorter, 2 in number and opposite. The inflorescence is an umbellate cluster of rose-purple

flowers with 1-5 long peduncles usually bearing a pair of leaves at the base of the pedicels. The sepals are 5 and awn-pointed. The petals are 5, hypogynous, and hairy at the base. The stamens are 10. The pistil is compound and shows a 5-lobed, 5-celled ovary which is terminated by a 5-cleft style. The fruit is a regma.

**Production and Commerce.**—The rhizome is collected in autumn, washed, deprived of most of its stem bases and roots and dried or, for use in homeopathic



FIG. 232.—*Geranium maculatum*.

medicine, processed while fresh into a mother tincture. The commercial supplies come from Virginia, North Carolina, Michigan and Indiana.

**Description.**—Usually simple, occasionally branched, horizontal, tuberculated rhizomes up to 10 cm. long and 3 to 15 mm. broad; externally dark purple or reddish-brown, the upper surface with circular stem scars and buds, the lateral surfaces and lower surface nodulated and annulated; fracture short and nearly even; internally showing a thin bark, a distinct cambium and a large grayish-purple pith; odor indistinct, taste very astringent.

**Powdered Drug.**—Purplish-brown. Numerous fragments of starch-, crystal- and tannin-parenchyma; starch grains numerous, ovoid or ellipsoidal, up to  $35\mu$  in length with excentric hilum; numerous rosette aggregate crystals of calcium oxalate up to  $145\mu$  in diameter (usually 60 to  $120\mu$ ); numerous fragments colored bluish-black with ammonio-ferric alum T.S.; small spiral and reticulate

tracheæ associated with porous and reticulate tracheids; fragments of cork tissue.

**Constituents.**—*Tannin*, belonging to the phlobaphene group (up to 27 per cent), starch and calcium oxalate.

**Use.**—Astringent.

**Average Dose.**—1 Gm. (15 grains).

#### OIL OF ROSE GERANIUM

**Oil of Rose Geranium** is a volatile oil distilled from the leaves and flowers of cultivated forms of *Pelargonium graveolens* L'Her., *P. odoratissimum* Ait.,



FIG. 233.—Geranium. Note the tuberculated surface of the rhizomes, also the stem scars and bases.  $\times \frac{1}{2}$ .

*P. roseum* Willd., *P. radula* (Cav.) L'Her., *P. crispum* (L.) L'Her. and hybrids (Fam. *Geraniaceæ*). S. Africa is believed to be the habitat of most of the *Pelargoniums*. The oil is secreted in the glandular hairs which occur on the stems, leaves and inflorescences. It is produced commercially chiefly in Reunion Island and Algeria and to a lesser extent in Madagascar, Italy, Russia, S. France and Spain.

It is a colorless, greenish or brownish fluid which, when first distilled, possesses a pelargonium odor but upon ageing in contact with air, develops a strong rose-

like odor. It contains chiefly the alcohols *geraniol* and *d*- and *l*-*citronellol*, but also linalool, phenyl-ethyl-alcohol,  $\alpha$ -terpineol, citral, borneol, methylheptenone, l-menthone, acetic, crotonic, butyric and valeric acids, etc. It is used as a perfume for cosmetics, soaps, etc.

#### LINACEÆ (FLAX FAMILY)

Herbs with slender stems and alternate, simple, narrow leaves. Inflorescence cymose with regular pentamerous flowers; pistil five-carpelled with a five-celled ovary containing two ovules in each cavity and having a single style with knob-like stigma. While the flower is still in bud condition or soon after, there commences an ingrowth of the mid-rib of each carpel which proceeds until, when plant is in fruit, there are formed 10 cavities each enclosing a seed. Seeds, anatropous, mucilaginous, flattened, containing a large embryo and slight albumen.

#### LINSEED N.F. (LINUM)

**Synonyms.**—*Flaxseed*; *Ger.* Flachssamen; *Fr.* Semence de Lin.

**Botanical Origin.**—*Linum usitatissimum* Linné.

**Part Used.**—The dried ripe seed.

**Standard of Assay.**—Not less than 30 per cent. of non-volatile, ether-soluble extractive, of which not more than 2 per cent is unsaponifiable matter.

**Limit of Impurities.**—2 per cent. of other seeds or foreign organic matter

**Habitat.**—Unknown. It is cultivated chiefly in the temperate regions of the Eastern and Western Hemispheres.

**Plant.**—An annual herb having an erect, smooth stem attaining a height of .7 m. and branching at the summit. The leaves are alternate, small, linear-lanceolate and sessile. The flowers are pale-blue and terminal. The fruit is a small globular capsule with persistent basal calyx and containing 10 exalbuminous seeds, one in each cell.

**Production and Commerce.**—Flax is grown for its seed and fiber in nearly all countries within the temperate zones as well as in some tropical regions. The countries yielding most of the world's supply of flaxseed are United States, Canada, Russia, Argentina, Uruguay, India and Holland. The seeds are sown in early spring on clean moist land with a grain drill, at a depth of about an inch. The plants are cut when the fruits are fully matured, bound and shocked, and the seeds separated by thrashing. The seed is then cleaned and stored in dry places until marketed. The two principal flaxseed markets in the United States are Minneapolis and Duluth. In 1946, the United States produced 22,962,000 bushels of flaxseed. The states yielding this quota in the order of their production were Minnesota, North Dakota, South Dakota, California, Kansas, Texas, Iowa, Montana, Arizona, Wisconsin, Michigan, Missouri, Oklahoma, Illinois, Nebraska and Wyoming. In 1945, 3,795,575 bushels of flaxseed were imported into this country from Canada, Argentina and Uruguay. During 1946, 3,393,702 bushels of flaxseed and 94,404,717 pounds of linseed oil were imported from these same countries.

**Description.**—The seed is exalbuminous, of compressed ovate or oblong-lanceolate outline, pointed at one end, rounded at the other and from 4 to 6 mm. in length; externally glabrous and shiny, brown to dusky red with a pale-yellow, linear raphe along one edge; the hilum and micropyle in a slight depression near the pointed end; internally exhibiting a brown seed coat and yellowish-green endosperm and cotyledons; odor slight, becoming very characteristic in the ground or crushed drug; taste mucilaginous and oily.

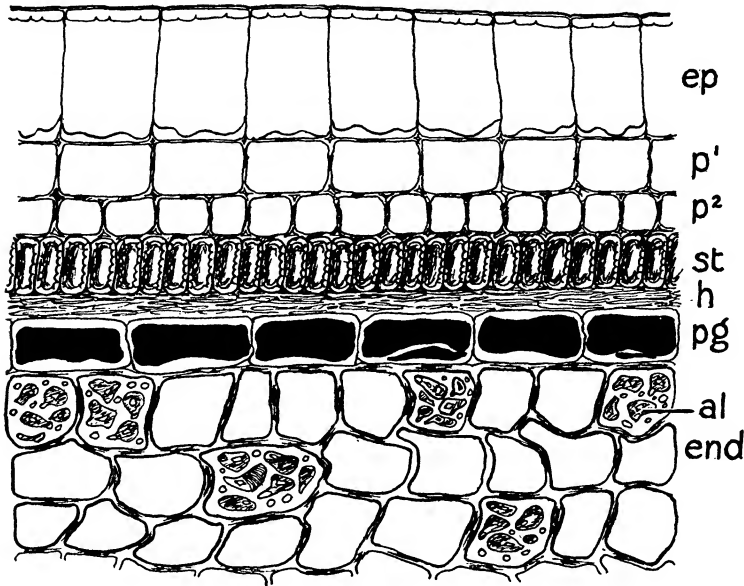


FIG. 234.—*Linum*. Cross section of seed coat and outer region of endosperm. *ep*, epidermis; *p¹*, *p²*, parenchyma cells; *st*, stone cells; *h*, hyaline layer; *pg*, pigment cell layer of seed coat; *end*, endosperm; *al*, aleurone grain.

**Histology.**—Transverse sections of this seed can readily be made by fixing in cork preparatory to cutting them. Upon mounting in chloral hydrate solution and examining under the microscope the following structures are apparent:

1. **Seed coat** consisting of the following regions; (*a*) Epidermis of a single layer of large cells with a mucilaginous outer wall covered by a very thin, more or less broken sheath of cutin, the wall showing stratification upon coming in contact with water; (*b*) two layers of more or less collapsed parenchyma cells with intercellular-air-spaces (in the region of the raphe, but one layer of these cells is evident and a bundle here traverses this tissue); (*c*) a layer of yellowish-brown, radially elongated and lignified stone cells with large central lumina; (*d*) a hyaline layer of narrow, elongated colorless cells; (*e*) a layer of pigment cells with red to orange amorphous contents.

2. **Endosperm** of from 6 to 10 layers of parenchymatous cells with moderately thickened walls and containing small aleurone grains and globules of fixed oil.

3. **Two large plano-convex Cotyledons**, each consisting of a covering outer epidermis of polygonal cells enclosing numerous radially-elongated cells that contain abundant aleurone and oil. The aleurone grains are from  $3\mu$  to  $20\mu$  (averagely 10 to  $15\mu$ ) in length and can best be studied in mounts stained with dilute iodine or picric acid solution. In such mounts each will be seen to consist of a protein matrix containing one or two more or less angular phytoglobulins and large rounded globoids.

**Ground Drug (Linseed Meal).**—Light yellowish-brown to weak yellow with numerous coarse dark-colored fragments of seed coat. **Powdered Drug,**

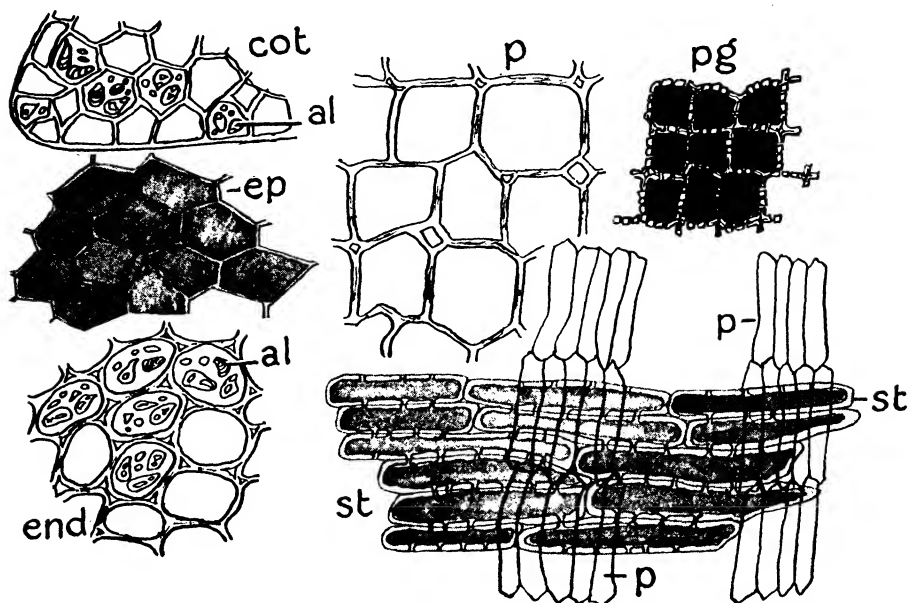


FIG. 235.—Ground Flaxseed. *ep*, epidermal cells in surface view with mucilage content; *st*, stone cells in longitudinal view with adherent parenchyma cells (*p*) crossing them; *end*, endosperm cells containing aleurone (*al*) and fixed oil droplets; *cot*, fragment of a cotyledon whose cells contain fixed oil and aleurone grains (*al*); *p*, parenchyma of seed coat in surface view; *pg*, pigment cells with porous walls and brownish content, in surface view.

yellowish-brown, greatly oleaginous. When defatted and examined microscopically it shows fragments of the seed coat having tabular pigment cells filled with a reddish-brown to yellowish-brown substance and radially elongated stone cells with orange to yellowish-brown, porous walls, fragments of endosperm and cotyledons composed of polygonal or elongated angular cells with colorless walls and aleurone contents. The aleurone grains are 3 to  $20\mu$  in diameter and can best be studied in dilute iodine or picric acid solutions.

**Constituents.**—30 to 40 per cent. of *fixed oil* (*Oleum Lini* N.F.) containing *linolein*; about 25 per cent. of protein, 6 per cent. of mucilage, etc.

**Uses.**—Demulcent, emollient and laxative; source of Linseed Oil N.F.

**Adulterants.**—Corn Meal, Wheat Middlings, Cake Meal sometimes containing a mineral oil, Foreign Weed Seeds.

**Linseed Oil** (*Oleum Lini*) N.F. (*Flaxseed Oil, Raw Linseed Oil*) is the fixed oil obtained from the dried ripe seed of *Linum usitatissimum* L. (Fam. *Linaceæ*). It is a yellow fixed oil having a peculiar odor and a bland taste. When exposed to air, it thickens, darkens in color and acquires a more pronounced odor and taste. It is slightly soluble in alcohol and miscible with turpentine oil, ether and petroleum benzin; sp. gr. 0.925 to 0.935 at 25°C.; saponification value 187-195; iodine value not less than 170. **Adulterants**—Non-drying oils, mineral oils, rosin oil, and rosin. Boiled linseed oil, which is used in the paint industry, must not be used or dispensed for medicinal purposes. Used in preparing Carron Oil and occasionally as a laxative. Average dose, 30 cc. (1 fl. oz.).

### ERYTHROXYLACEÆ (COCA FAMILY)

A small family of tropical plants, mostly shrubs, closely allied anatomically to the *Linaceæ*, with pentamerous flowers and drupe fruits. The outstanding histological characteristics are the presence of sclerenchyma fibers in the pericycle, thin-walled cork cells, rosette crystals or monoclinic prisms of calcium oxalate and superficial development of cork. The development of papillæ on the lower leaf epidermis is recorded for most species of *Erythroxylon*.

### COCA (COCA LEAVES)

**Synonyms.**—Cocæ Folia; *Ger.* Cocablätter; *Fr.* Feuilles de Coca.

**Botanical Origin.**—*Erythroxylon Coca* Lamarck, *E. truxillense* Rusby and *E. novogranatense* Hieronymus.

**Part Used.**—The dried leaf.

**Habitat.**—South America, probably Peru and Bolivia.

**Plants.**—Shrubs which under cultivation attain the height of 6 ft., with slender branches, alternate, entire, oval to elliptic leaves, small white or yellow flowers and red, 1-seeded drupes.

**Production and Commerce.**—The coca shrubs are extensively cultivated in Bolivia and Peru where they grow on the slopes of valleys in the Andes at an elevation of from 1500 to 6000 ft. and in a moist atmosphere. They are also cultivated in Java, Formosa and Ceylon. Peru produces the largest amount of drug, although the province of La Paz in Bolivia yields the largest crop of any district. The seeds are planted in nurseries and when the seedlings are sufficiently strong these are transplanted to long terraces called "humachas" built up above one another like the steps of a staircase, each being supported by a little rampart of earth reinforced by stones. The plants begin to yield in about 18 months but it takes from 3 to 5 years for the coca shrub to be in full bearing. There are three pickings a year, occasionally a fourth. The mature leaves are plucked by the Andean Indians and dried, first in a closed drying chamber where the leaves are spread on a floor of beaten earth and afterwards on a paved open drying floor. They are then stored in dry buildings and subsequently packed in bales. Although produced in large quantities, comparatively little of the crude drug is shipped out of South America. Most of it is consumed



by the natives while considerable is employed in the manufacture of cocaine. Peru exports considerable crude cocaine.

The commercial varieties of Coca leaves are the Huanuco or Bolivian Coca yielded by *Erythroxylon Coca*, the Peruvian or Truxillo Coca, yielded by *E. truxillense* and the Java Coca yielded by *E. novogranatense*. During 1947 this country imported 648,882 pounds of Coca leaves from Peru.

**Description.**—*Huanuco Coca*.—Brownish-green, mostly entire, shortly and stoutly petioled; the blade elliptical, thick, slightly coriaceous, averagely from

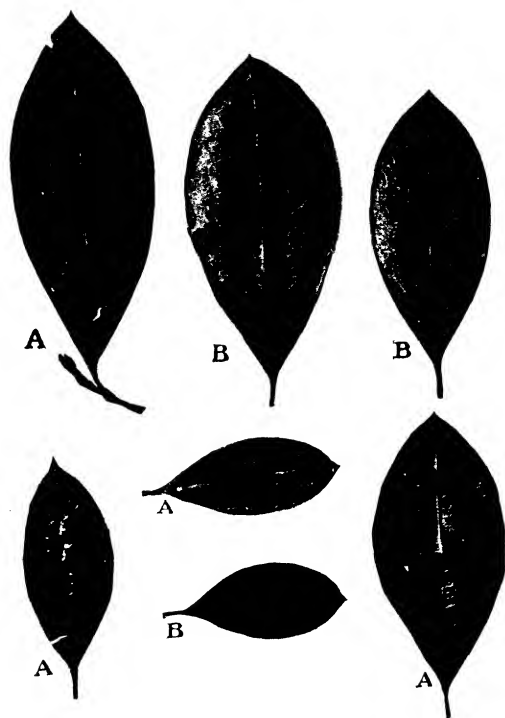


FIG. 236.—Coca Leaves. A, Upper side. B, Lower side. Natural size. (After Sayre.)

3.5 to 8 cm. in length and from 2.5 to 4 cm. in breadth, glabrous, apex acute, base tapering, margin entire; midrib reddish-brown, traversed on the upper surface by a slight ridge, very prominent on lower surface, the remaining venation somewhat obscure, especially above; on lower surface, 2 conspicuous curved lines of collenchyma tissue run longitudinally, one on either side of the midrib and about  $\frac{1}{3}$  of the distance between it and the margin; odor slightly tea-like; taste bitter and slightly aromatic followed by a sensation of numbness.

*Truxillo Coca*.—Pale green, brittle and usually considerably broken, shortly and stoutly petioled; the blade obovate to oblanceolate, 1.6 to 5 cm. in length and  $\frac{1}{3}$  to  $\frac{1}{2}$  as broad, glabrous, much thinner than the Huanuco variety, apex acute, narrowed from near the middle to the petiole, margin entire; on lower surface 2 curved lines of collenchyma tissue, usually incomplete or obscure

(frequently absent) run longitudinally one on either side of the green midrib; odor tea-like; taste and numbing sensation similar to Huanuco variety.

*Java Coca*.—Similar to Truxillo, but only seen in commerce in powdered form and employed for the manufacture of cocaine in Germany, Holland and America.

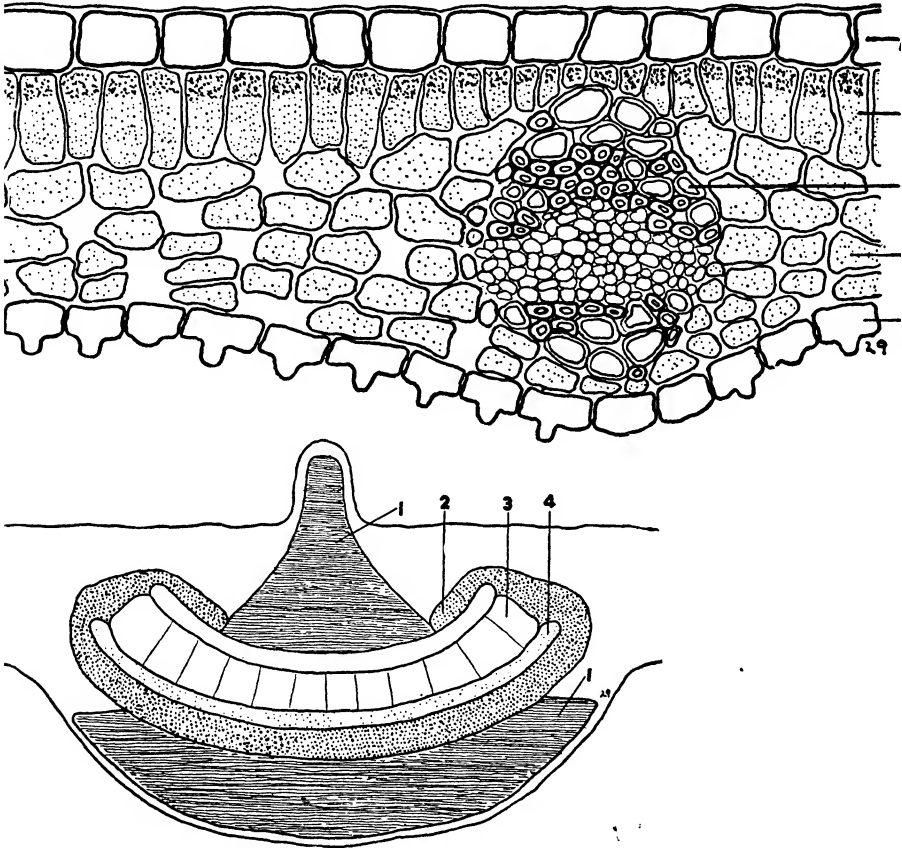


FIG. 237.—Peruvian or Truxillo Coca (*Erythroxylon truxillense* Rusby). Upper: Leaf in cross section: A, upper epidermis; B, palisade parenchyma; C, spongy parenchyma; D, lower epidermis, showing papillæ; F, veinlet. Lower—Midvein Section: 1, collenchyma; 2, fibers; 3, vessels; 4, sieve tissue. [Drawings after Ballard, *Jour. A. Ph. A.* 15 (1926) 440.]

**Powdered Coca.**—Dark green; numerous fragments of mesophyll; monoclinic prisms of calcium oxalate up to  $15\mu$  in diameter or in crystal fibers, the latter accompanying sclerenchyma fibers; fragments of tracheæ; fragments of upper epidermis with polygonal-shaped epidermal cells; fragments of lower epidermis with polygonal-shaped epidermal cells and stomata, the latter usually with 2 neighboring cells parallel to the stoma; papillæ short, rounded, conical and appearing as circular markings in center of each lower epidermal cell.

**Constituents.**—The alkaloids *cocaine*, *cinnamyl-cocaine*,  $\alpha$  and  $\beta$  *truxilline*, *hygrines*; *coca-tannic acid*, etc. When hydrolyzed all the alkaloids of coca

yield the crystalline alkaloid ecgonine. Bolivian Coca is said to yield the greatest percentage of cocaine.

Cocaine ( $C_{17}H_{21}O_4N$ ), the chief active principle, occurs in colorless to white monoclinic crystals or as a white powder; 1 Gm. is soluble in 600 cc. of water and

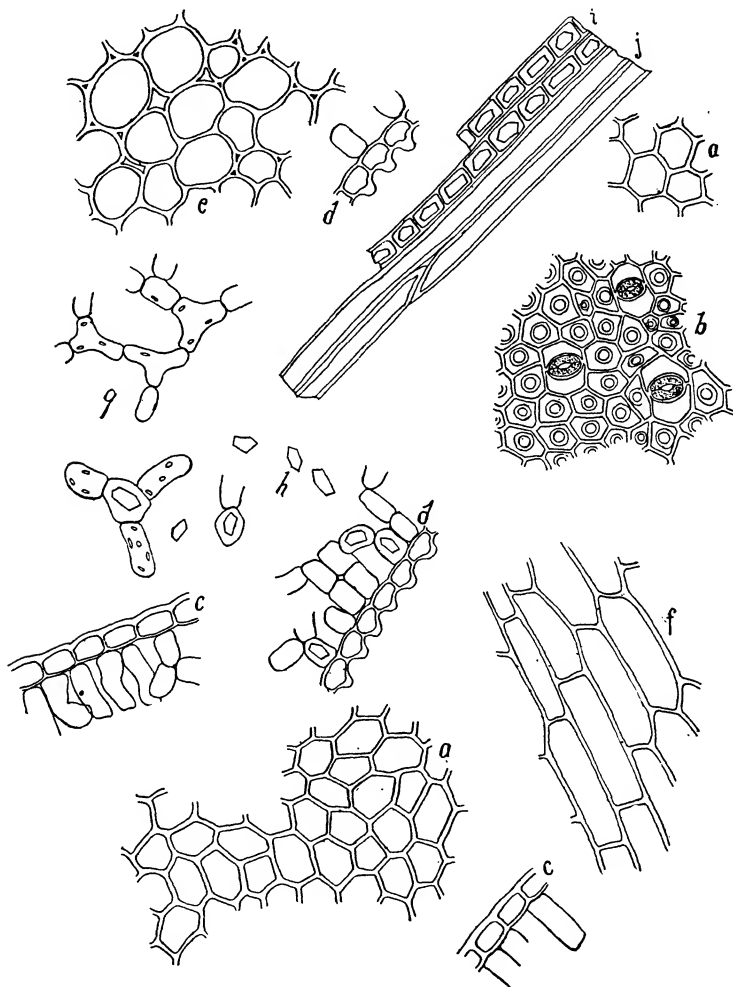


FIG. 238.—Powdered Coca. *a*, upper epidermis in surface view; *b*, lower epidermis showing papillae and stomatal apparatus in surface view; *c*, upper epidermis and palisade parenchyma layer, lateral view; *d*, lower epidermis showing papillae in lateral view together with portion of spongy parenchyma; *e*, parenchyma; *f*, parenchyma in longitudinal view; *g*, spongy parenchyma; *h*, hexagonal prisms of calcium oxalate; *i*, crystal fibers adherent to sclerenchyma fibers (*j*). (After Schneider.)

in 0.7 cc. of alcohol, in about 12 cc. of olive oil, and in about 80 to 100 cc. of liquid petrolatum at 25°C. Its melting range is between 96° and 98°C. Its hydrochloride is readily soluble in water, glycerin and alcohol.

If a drop of gold chloride T.S. be added to a 1:1000 solution of cocaine on

a micro-slide, an amorphous precipitate first forms which slowly changes to "fern-frond" like crystals of cocaine-chlor-aurate.

**Uses.**—The leaves are chewed with lime by the natives as a stimulant, restorative and tonic. Their chief pharmaceutical use is in the manufacture of cocaine, the latter being employed surgically as a local anæsthetic.

**Cocaina U.S.P.** (Cocaine) is an alkaloid obtained from the leaves of *Erythroxyton Coca* Lamarck and other species of *Erythroxyton* (Fam. *Erythroxylaceæ*), or by synthesis from ecgonine or its derivatives. Cocaine and Cocaine Hydrochloride are employed owing to their power to block afferent nerve impulses and to shrink swollen tissue. Their properties are analgesic, mydriatic, cerebral stimulant, local anesthetic and antiemetic.

**Average Dose** (unof.) of Cocaine U.S.P. and Cocaine Hydrochloride U.S.P.—0.015 Gm. ( $\frac{1}{4}$  grain).

### ZYGOPHYLLACEÆ (CALTROP FAMILY)

*Zygophyllaceæ* or *Caltrop Family*.—Herbs, shrubs or trees (*Guaiacum*) having jointed, often divaricate branches. Leaves usually opposite, stipulate and compound. Flowers regular or irregular, pentamerous, white, yellow, red or blue (*G. officinale*). Fruit a capsule.

### GUAIAC N.F. (GUAIACUM)

**Synonyms.**—*Guaiac Resin*, Gum Guaiac; *Fr.* Résine de Gayac; *Ger.* Guajakharz.

**Botanical Origin.**—*Guaiacum officinale* L. and *Guaiacum sanctum* L.

**Part Used.**—The resin of the wood.

**Purity Rubric.**—Not more than 15 per cent. of alcohol-insoluble residue, and not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—South America and West Indies.

**Plants.**—Evergreen trees with ash-gray bark, knotty branches, resinous wood and paripinnate leaves. The flowers are large, of blue to purple color, and occur in axillary clusters. The fruit is a capsule.

**Production and Commerce.**—Resin of Guaiac naturally exudes from the Guaiac trees but the commercial article is obtained largely by cutting incisions in the bark of the trees or by heating the ends of logs that have first been scarified in the middle and suspended horizontally in the air by appropriate supports. The resin runs out from the scarified area and is collected in calabash cups. The commercial supplies are chiefly obtained from Azua, Dominican Republic, and from Gonaives, Haiti, and arrive in bags packed within cases.

**Description.**—In irregular masses enclosing fragments of plant tissues, or in large, nearly homogeneous masses, occasionally in round or ovoid tears; externally deep greenish-brown or dark olive color on surfaces exposed to the air and brownish black to dusky brown on freshly fractured surfaces; brittle, the freshly fractured surface having a glassy lustre; odor balsamic; taste slightly acrid. Not more than 15 per cent. is insoluble in alcohol.

An alcoholic solution on the addition of ferric chloride tincture or oxidizing agents or enzymes becomes blue changing rapidly to green.

**Constituents.**—*Guaiaconic acid* (70.5 per cent.), *guaiaretic*, *guaiacinic*, *guaiacresinic* and *guaiacic* acids, guaiacsaponin, vanillin, an aromatic volatile oil, a guttapercha-like substance called guaiaguttin, guaiac yellow, etc.

**Uses.**—Stimulant, diaphoretic, expectorant, laxative, and astringent.

**Average Dose.**—1 Gm. (15 grains).

**Preparation.**—Ammoniated Guaiac Tincture, 2 cc. (30 minims).

#### RUTACEÆ (RUE AND CITRUS FAMILY)

Herbs (*Ruta*), shrubs (*Barosma*), shrubs or trees (*Ptelea*, *Zanthoxylum*) or trees (*Citrus*). Stems upright, often wiry xerophytic, in sub-family *Ruteæ*, elongated and spiny in sub-family *Zanthoxyleæ*, woody and green in sub-family *Aurantieæ*. Leaves alternate or opposite, simple (*Ruta*), rarely whorled (*Pilocarpus*), or pinnatifid, as in *Ruta graveolens*, or pinnate, as lower parts of *Ruta graveolens*, becoming reduced-pinnate in *Citrus Aurantium*. Leaves exstipulate or with spiny stipules (*Zanthoxylum*). Stems and leaves abound in more or less sunken glands. Flowers pentamerous, varying in color from yellow in *Ruta* to white in *Citrus* to pink (*Barosma betulina*) or pink crimson, as in some *Barosma* and *Diosma* species, rarely to pinkish-purple (*Pilocarpus*); sepals five, aposepalous, becoming in *Citrus* more or less synsepalous; petals five, apopetalous, becoming more or less synpetalous and tubular (*Correa grandiflora*); stamens five, simple or with expanded bases, lobed, or lobes developed as staminal stipules and more or less split (*Citrus*); pistil of ten, five, three or two carpels, ovary as many-celled. Fruit follicles (*Barosma*, *Zanthoxylum*), a hesperidium (*Citrus*) or rarely a samara (*Ptelea*). Seeds albuminous or exalbuminous. Many of the plants contain volatile oils in their secretory cavities. Membrane crystals and hesperidin are common to the *Citrus* spp. Pericyclic fibers occur usually in isolated groups within the plant axis.

#### RUE (RUTA)

**Ruta** or **Rue** consists of the dried leaves of *Ruta graveolens* L., a hardy perennial aromatic undershrub with 2- to 3-pinnatifid leaves, the ultimate lobes of which are cuneate-obovate, and yellow flowers arranged in cymes. It is native to Europe and naturalized and cultivated in the U. S. It contains a volatile oil containing methyl-nonylketone, 2 ketones, pinene, *l*-limonene, cineol, etc., rutin, and a coloring principle called rutinic acid. It is used as a calmate, in colic and atonic amenorrhea. Large doses are irritant.

#### BUCHU N.F. (BUCHU)

**Synonyms.**—Bookoo, Buku, Bucco, Diosma; *Fr.* Feuilles de buchu; *Ger.* Buccoblätter.

**Botanical Origin.**—*Barosma betulina* (Thunberg) Bartling and Wendland, *Barosma crenulata* (Linné) Hooker, and *Barosma serratifolia* (Curtis) Willdenow.

**Part Used.**—The dried leaf.



FIG. 239.—*Barosma serratifolia*, the source of Long Buchu. Leaf and flowering branches.

**Purity Rubric.**—Buchu contains not more than 8 per cent. of the stems of the plants yielding Buchu and not more than 2 per cent. of other foreign organic matter, yields not more than 1 per cent. of acid-insoluble ash and not less than 1.25 cc. of volatile oil of Buchu from each 100 Gm. of drug.

**Habitat.**—South Africa.

**Plants.**—Low shrubs with glandular-punctate twigs and angled branches. The leaves are small, opposite, coriaceous and pellucid-punctate. The leaves are obovate or rhomboidally obovate (*B. betulina*) or linear-lanceolate (*B. serratifolia*) with more or less serrulate margins. The flowers are pink to white. The fruit consists of 5 follicles.

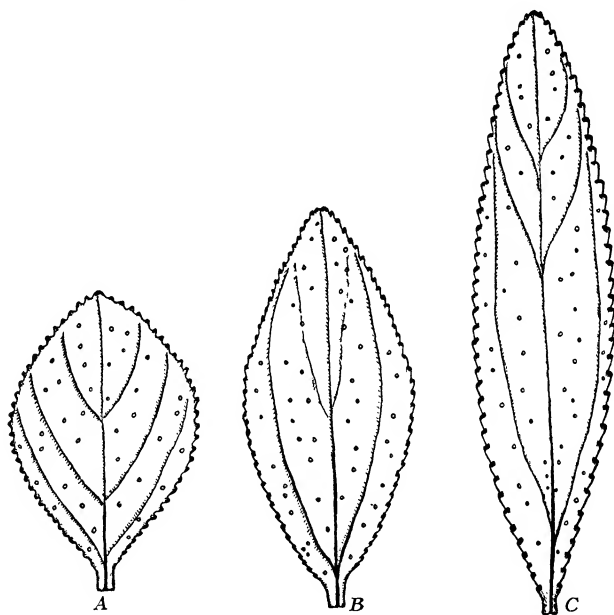


FIG. 240.—Buchu, showing upper surface of leaves of three commercial varieties. A, Short Buchu (*Barosma betulina*). B, Ovate Buchu (*Barosma crenulata*). C, Long Buchu (*Barosma serratifolia*).

**Production and Commerce.**—The leaves are gathered in the Cape Colony district of South Africa by the natives who cut off the branches when the shrubs are in flower or fruit, allow them to dry and then beat off the leaves. The supply used by this country comes from Cape Town, South Africa. Buchu is shipped in large bales. Short Buchu represents the leaves of *B. betulina* and *B. crenulata* whereas Long Buchu consists of the leaves of *B. serratifolia*.

**Distinctions between the Commercial Varieties of Buchu.**—

	BAROSMA BETULINA (SHORT BUCHU)	BAROSMA SERRATIFOLIA (LONG BUCHU)
Outline		
of Blade:	Rhomboidally oval or obovate.	Linear lanceolate.
Apex:	Obtuse or rounded, sometimes recurved.	Rounded or truncate.

	BAROSMA BETULINA (SHORT BUCHU)	BAROSMA SERRATIFOLIA (LONG BUCHU)
Base:	Cuneate or obtuse.	Acute.
Margin:	Serrulate to denticulate with an oil-gland at base of each tooth.	Serrulate with an oil-gland at the base of each tooth.
Up. Surface:	Pale olive, papillose.	Dark-green to yellowish-green, papillose.
L. Surface:	Yellowish-green, pellucid-punctate, and longitudinally striate.	Grayish-green, pellucid-punctate, and longitudinally striate.
Size:	9-30 mm. long $\times$ 4-20 mm. broad.	8-40 mm. long $\times$ 4-10 mm. broad.
Texture:	Brittle and coriaceous.	Coriaceous.
Odor:	Aromatic, mint-like.	Aromatic, mint-like.
Taste:	Pungent, camphoraceous.	Pungent, camphoraceous.

The leaves of *Barosma crenulata* or *Ovate Buchu*, also known commercially as *Short Buchu*, somewhat resemble both of these other species, differing chiefly in their outline which is oblong-ovate to lanceolate (broader than Long Buchu), in their apex which is obtuse like *B. betulina* but not recurved, and in the petiole which is about 2 mm. in length.

**Histology.**—Transverse and surface sections of either of the varieties exhibit the following structural characteristics, when studied microscopically:

1. *Upper epidermis* devoid of stomata, but with a thick uneven and striate cuticle and with cells containing spherocrystals or crystal aggregates of hesperidin which strongly polarize light. The inner walls of these cells are composed of a mucilaginous modification of cellulose which breaks down into mucilage, when dry-cut transverse sections are mounted in water, causing the separation of the epidermis from the underlying layer of hypodermal cells with a resultant elongated rent in the section.

2. *Hypodermis*, a subepidermal layer of large cells containing mucilage and often dark, feather-like crystal aggregates.

3. *Palisade Parenchyma*, a single row of columnar cells rich in chloroplastids, a few containing rosette aggregates of calcium oxalate.

4. *Spongy Parenchyma*, a zone of loosely arranged mesophyll cells and air-spaces, the cells mostly containing chloroplastids; a few rosette aggregates of calcium oxalate. Fibrovascular bundles of the open collateral type course through this region. In the midrib and larger vein regions they are arranged in crescent-shaped groups and separated from the lower epidermis by collenchyma.

5. *Lower epidermis* with thick cuticle and numerous broadly oval stomata, the latter surrounded by from 4 to 6 neighboring cells. The lower epidermal cells are polygonal in surface sections and contain sphaerocrystals of hesperidin.

A few unicellular, non-lignified, non-glandular hairs occur on petiole and stem epidermis. These are up to  $145\mu$  in length in Short Buchu and up to  $180\mu$  in length in Long Buchu. Spherical-shaped internal glands containing oil globules occur in the mesophyll, mostly near the margins of the leaf.

The palisade ratio range of the leaves of *Barosma betulina* is 10-26.

When an alcoholic extract of Buchu is examined under ultra-violet light no blue fluorescence is produced.



**Powdered Drug.**—Dusky greenish-yellow to moderate greenish-yellow. Characteristic elements: Epidermal cells with straight vertical walls and containing sphaero-crystals or crystal aggregates of hesperidin, 30 to 50 $\mu$  in diameter; numerous oil globules; numerous elliptical stomata with 4 to 6 neighboring cells in lower epidermis; rosette crystals of CaO, 15 to 30 $\mu$  in diameter; few

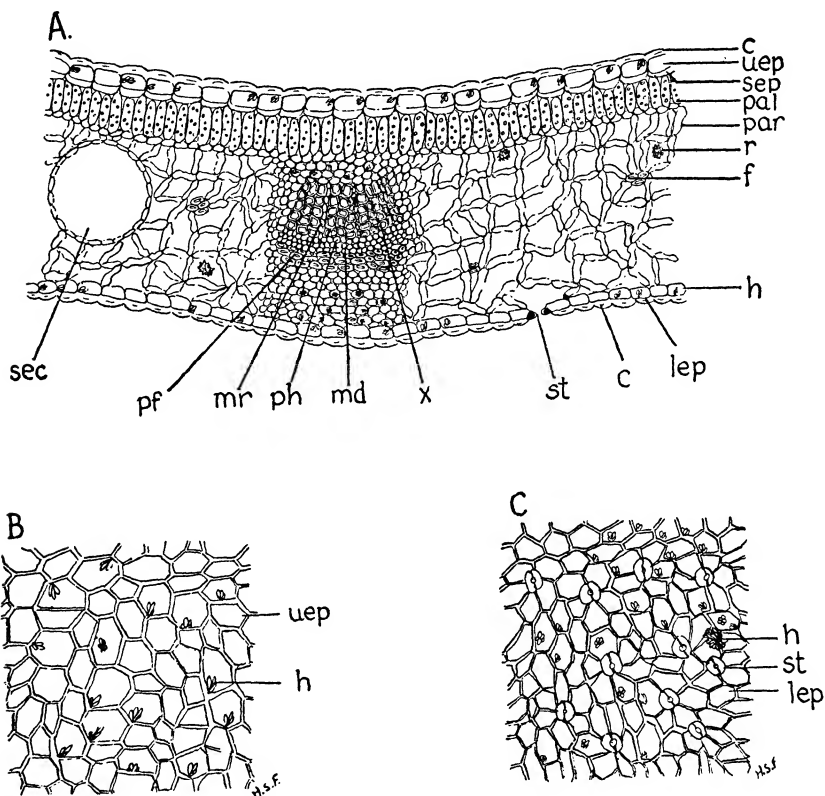


FIG. 241.—Short Buchu (*Barosma betulina*). A, Transverse section of portion of leaf blade, *md*, the mid rib region. B, Surface section of upper epidermis. C, Surface section of lower epidermis. *c*, cuticle; *uep*, upper epidermis; *sep*, pseudo-hypodermis; *pal*, palisade parenchyma; *par*, spongy parenchyma; *r*, rosette aggregate of calcium oxalate; *h*, hesperidin, in A, cell containing hesperidin; *st*, stoma; *sec*, secretion reservoir; *pf*, pericyclic fibers; *ph*, phloem; *mr*, medullary ray; *x*, xylem. (Drawing by H. S. Feldman.)

unicellular, non-glandular hairs from stems and petioles up to 180 $\mu$  in length. The palisade ratio is never less than 10 for Buchu yielded by *Barosma betulina* and never less than 8 for Buchu yielded by *Barosma crenulata* and *B. serratifolia*.

**Constituents.**—*Volatile oil* with a peppermint-like odor (up to 2.5 per cent.) containing *diosphenol*, *L-menthone*, *d-limonene* and *dipentene*; the crystalline glycosides *diosmin* and *hesperidin*; mucilage, occurring in the subepidermal layer of cells of the leaves, etc. About 50 per cent. of the volatile oil consists of laevogyrate menthone and from 17 to 30 per cent. consists of optically inactive *diosphenol*. The diuretic action of the drug is ascribed to *diosphenol*.

**Adulterants and Substitutes.**—The leaves of *Empleurum ensatum* (*Rutaceæ*) have been substituted for Long Buchu. These are narrower, have a bitter taste, an acute apex and are without an oil-gland at the base of each tooth.

The leaves of *Barosma pulchella* are smaller than the official *Buchus* and possess an odor of citronella.

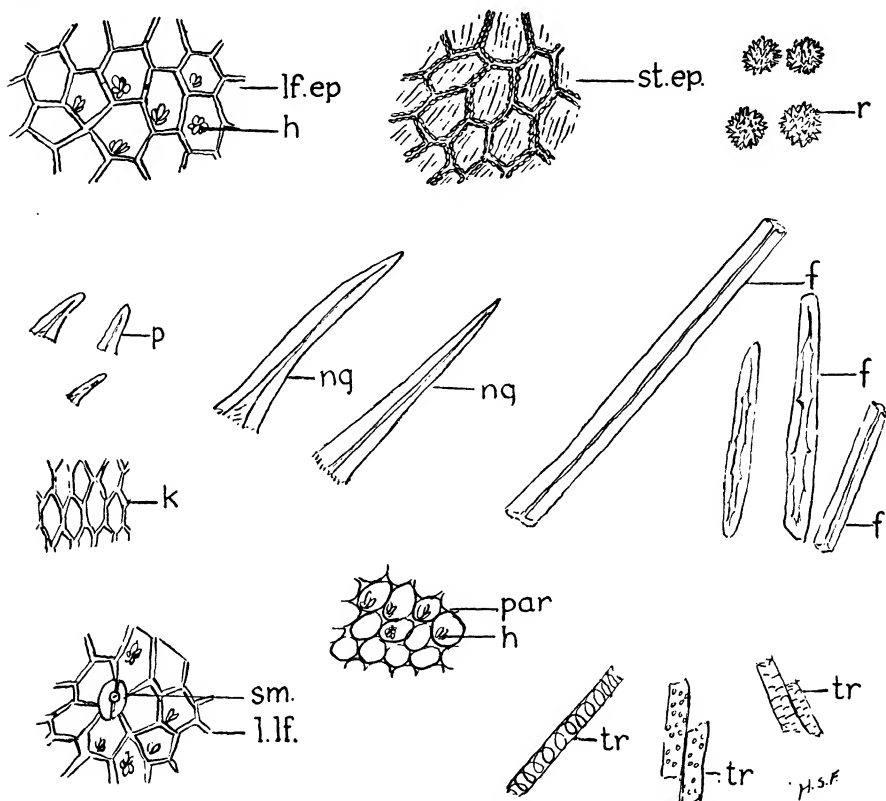


FIG. 242.—Powdered Buchu. *lf.ep.*, upper epidermis of leaf; *h*, crystals of hesperidin; *st.ep.*, epidermis of stem; *r*, rosette aggregates of calcium oxalate; *p*, papilla-like hairs; *ng.*, unicellular, non-glandular hairs from Buchu stem sometimes present as a contaminant; *f*, sclerenchyma fibers; *l. lf.*, lower epidermis of leaf showing stoma (*sm*) surrounded by 5 neighbor cells; *par*, leaf parenchyma; *tr*, tracheæ. (Drawing by H. S. Feldman.)

The leaves of *Diosma succulenta* (Fam. *Rutaceae*) known as Karoo Buchu, a South African shrub, which contain an oil having a peppermint odor. They are ovate, obtuse and somewhat recurved at apex, up to 6 mm. long and coriaceous.

The leaflets of *Psoralea obliqua* (Fam. *Leguminosae*), a South American shrub, which are inequilateral, dentate, show many non-glandular hairs and possess a bitter taste.

**Uses.**—As a disinfectant to the urinary tract in cystitis, pyelitis, urethritis and prostatitis; diuretic.

**Average Dose.**—2 Gm. (30 grains).

**Preparations.**—Buchu Fluidextract, 2 cc. (30 minims); Buchu, Juniper, and Potassium Acetate Elixir, 4 cc. (1 fl. dr.).

### PILOCARPUS (PILOCARPUS)

**Synonyms.**—Jaborandi, Jaborandi Leaves; *Ger.* Jaborandiblätter; *Fr.* Jaborandi.

**Botanical Origin.**—*Pilocarpus Jaborandi* Holmes and *Pilocarpus microphyllus* Stapf.

**Part Used.**—The dried leaflets.

**Purity Rubric.**—Not more than 5 per cent. of the stalks bearing the leaflets and stems of the same plant or other matter. It yields not less than 0.6 per cent. of the alkaloids of pilocarpus and not more than 7 per cent. of ash.

**Habitat.**—Brazil, in open forests.

**Plants.**—Shrubs with imparipinnate leaves usually having 3 pairs of leaflets and a terminal leaflet, and racemes of small pinkish-purple flowers. The fruit consists of 5 follicles.

**Production and Commerce.**—The shrubs grow on hill sides and in open forests of Brazil. *Pilocarpus Jaborandi* is abundant near Pernambuco while *P. microphyllus* thrives near Maranhão. Hence the product of the former species is known commercially as “Pernambuco Jaborandi” and that of the latter, as “Maranhão Jaborandi.”

#### DISTINCTION BETWEEN VARIETIES OF PILOCARPUS

	PERNAMBUCO JABORANDI	MARANHÃO JABORANDI
Outline:	Elliptical, oblong to oblong-ovate. 4-10 cm. long. 1.5-4.5 cm. broad.	Obovate to rhomboidally ovate. 1.5-5 cm. long. 1.5-3 cm. broad.
Base:	Unequal.	Tapering into petiole.
Apex:	Emarginate.	Deeply emarginate.
Margin:	Entire and slightly revolute.	Entire and revolute.
Up. Surface:	Dk. green to brownish-green.	Grayish to yellowish-green.
L. Surface:	Yellowish- or greenish-brown.	Grayish to yellowish-green.
Texture:	Coriaceous, brittle.	Coriaceous but less than half as thick as Pernambuco variety.
Odor:	Slight	Slight
Taste:	Bitter	Bitter

**Histology.**—Sections of Jaborandi leaflets, cut through the lamina, present the following structures for examination:

1. *Upper epidermis* of more or less tangentially elongated cells, as observed in cross section, with a thick, yellow outer cuticle and frequently showing out-growths in the form of long, yellowish, thick-walled, unicellular, non-glandular, bent or curved hairs.

2. *Palisade parenchyma* consisting of from 1 to 3 layers of columnar cells mostly possessing chloroplasts, some, rosette aggregates of calcium oxalate. Scattered amongst these cells are large, more or less spheroidal internal glands containing oil globules.

3. *Spongy parenchyma*, a broad zone of irregularly shaped cells and prominent intercellular spaces. Many of the cells in this region possess a rosette aggregate of calcium oxalate, others reddish-brown tannin masses.

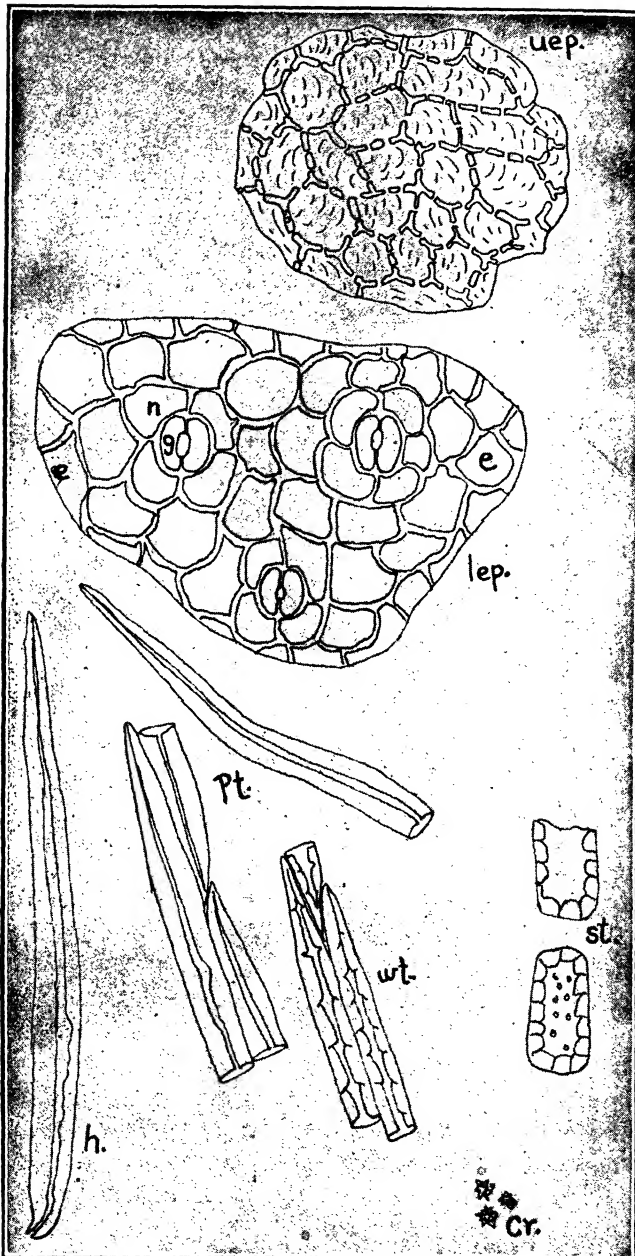


FIG. 243.—Powdered *Pilocarpus*. *uep*, upper epidermis; *lep*, lower epidermis (*e*, epidermal cells; *g*, guard cell; *n*, neighboring cell); *h*, non-glandular hair; *pt*, pericyclic fibers; *wt*, wood fibers; *st*, stone cells; *cr*, rosette aggregates of calcium oxalate. (Drawing by S. Mushlin.)

4. *Lower epidermis* of more or less tangentially-elongated epidermal cells and stomatal apparatuses. The outer walls of the epidermal cells are covered by a thick yellow cuticle. Hairs similar to those which occur on the upper epidermis are present but more numerous. In surface view the stomata appear more or less rounded and usually surrounded by 4 narrow neighboring cells.

The *midrib* region shows a partial circle of collateral bundles separated by narrow medullary rays and surrounded by an interrupted circle of several rows of thick-walled, slightly lignified, pericyclic fibers.

**Powdered Drug.**—Dark green or greenish-brown; epidermal cells in surface view, 5- or 6-sided; stomata broadly elliptical, usually with 4 neighboring cells; fragments of fibro-vascular bundles with simple or bordered pored and spiral tracheæ associated with thick-walled wood fibers; relatively few thick-walled and slightly lignified pericyclic fibers; rosette aggregates of calcium oxalate up to  $25\mu$  in diameter; fragments of mesophyll containing internal glands up to  $150\mu$  in diameter; oil globules; unicellular, non-glandular hairs with thick cutinized walls and numerous slight centrifugal projections.

**Constituents.**—The alkaloids *pilocarpine* ( $C_{11}H_{16}O_2N_2$ ) (0.5 to 1 per cent.) *isopilocarpine*, *pilocarpidine*, and *pilosine*; volatile oil, resin, etc. *Pilocarpine*, the chief active principle, is a colorless liquid freely soluble in water, alcohol or chloroform but almost insoluble in ether. Jaborine is a mixture of pilocarpine, isopilocarpine and extractive matter.

**Uses.**—Pilocarpus and the salts of pilocarpine are employed as a diaphoretic, especially in nephritis with uremia and in dropsy, as a sialagogue, and in hair preparations. Both the hydrochloride and nitrate of its alkaloid pilocarpine are official and are used in buffered isotonic solutions of 1:200 in the eye as a myotic to hasten the contraction of the pupil after mydriatics, and in glaucoma. Internally in congestion of the middle and inner ear, in alopecia, and as a physiological antidote for atropine or belladonna poisoning.

**Average Dose**, 2 Gm. (30 grains); of pilocarpine nitrate U.S.P. or pilocarpine hydrochloride N.F., 5 mg. ( $\frac{1}{12}$  grain).

**Adulterants.**—Leaflets of other species of *Pilocarpus* and of species of *Swartzia*.

Paraguay Jaborandi consists of the leaflets of *Pilocarpus pennatifolius* Lemaire. These are grayish-green, ovate, obovate or oblong-lanceolate with equal base, slightly revolute margin and only about half as thick as Pernambuco Jaborandi. It contains about 0.25 per cent. of alkaloids.

#### XANTHOXYLUM (XANTHOXYLUM)

**Synonyms.**—Prickly Ash Bark, Toothache-Bark or Tree, Yellow Wood; *Fr.* Clavallier; *Ger.* Zahnwehrinde.

**Botanical Origin.**—(1) *Zanthoxylum americanum* Miller (Northern Prickly Ash) and (2) *Zanthoxylum Clava-Herculis* Linné (Southern Prickly Ash).

**Part Used.**—The dried bark.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—(1) In rocky woods and along streams, Quebec to Minnesota, south to Virginia, Kentucky, Missouri and Kansas. (2) In dry soil along the sandy coast from Virginia to Florida and west to Texas.

**Plants.**—*Zanthoxylum americanum* Miller, commercially known as Northern Prickly Ash, but also as Toothache Tree, Angelica Tree and Yellow- or Pepper Wood, is a shrub growing to the height of about 4 m. with grayish, pungent bark covered with numerous white lenticels and scattered prickles. Its leaves are alternate, imparipinnate with 5 to 6 ovate-oblong leaflets that are downy when young. Its yellowish-green flowers appear before the leaves in sessile, axillary, umbellate clusters. Its fruit consists of 2 follicles each containing a single black seed.

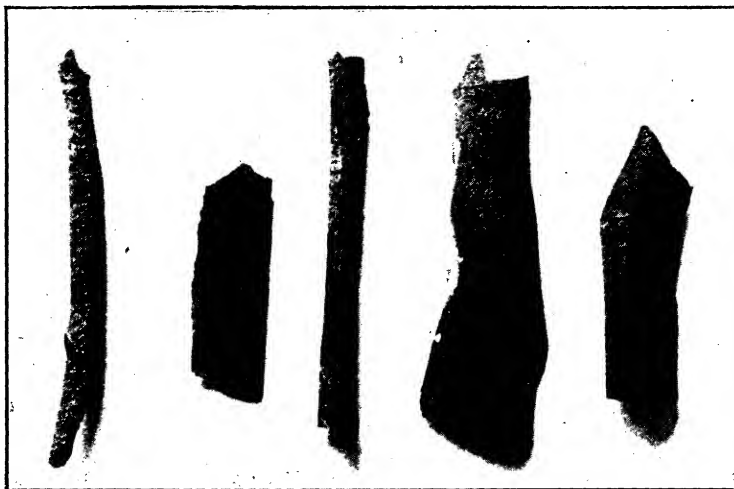


FIG. 244.—Northern prickly ash bark.

*Zanthoxylum Clava-Herculis* L., known as Southern Prickly Ash, Sea-Ash or Prickly Yellow Wood, is a small tree attaining a height of 12 m., purple-gray, whose aromatic and pungent bark shows numerous corky cones through which prickles protrude. Its leaves are alternate, imparipinnate and prickly with 7 to 17 ovate-oblong leaflets that are shiny on the upper surface. Its flowers appear after the leaves in terminal panicles.

**Description.**—**Northern Prickly Ash Bark.**—In irregular flattened pieces, transversely curved pieces or quills, from 2 to 15 cm. in length; bark from 0.5 to 2 mm. in thickness; outer surface olive-gray to brownish gray with lighter colored patches of foliaceous lichens bearing numerous small black apothecia; longitudinally wrinkled and with numerous whitish lenticels; the cork occasionally abraded, showing the greenish or brownish middle bark; inner surface weak yellowish-orange to light olive brown, finely longitudinally striate and usually with numerous, bright, shining crystals; fracture short, uneven; odor slight; taste bitter, acrid, becoming pungent.

**Description.**—**Southern Prickly Ash Bark.**—In transversely curved or irregular, oblong, flattened pieces, or in quills from 2 to 40 cm. in length, and

from 1 to 4 mm. in thickness; outer surface brownish-gray to olive-gray, marked by numerous large, barnacle-shaped projections of brownish cork, from 0.5 to 3.5 cm. in thickness, and frequently with numerous lighter colored patches of foliaceous lichens, and numerous, elliptical lenticels; inner surface weak yellowish orange to light olive brown, obscurely longitudinally striate, some pieces showing minute crystals, others devoid of them; odor and taste as in Northern Prickly Ash Bark.

**Powdered Southern Prickly Ash.**—Light yellowish brown; numerous irregular fragments of cork cells, nearly colorless or gray, brown to greenish yellow, and strongly lignified; fragments of parenchyma some containing small, nearly spherical starch grains from 2 to  $10\mu$  in diameter, oily globules or monoclinic prisms of calcium oxalate from 10 to  $45\mu$  in length; stone cells up to  $150\mu$  in length in small groups with thick, yellowish walls and containing frequently orange to brown cell contents; bast-fibers few and non-lignified.

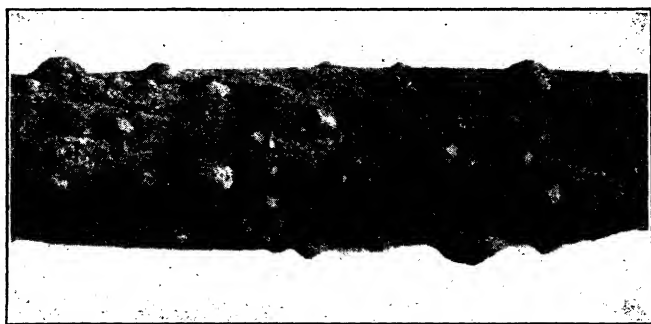


FIG. 245.—Southern prickly ash bark.

**Powdered Northern Prickly Ash.**—Similar to the preceding but stone cells are comparatively few and there are fewer cork cells.

**Constituents.**—Two resins, an acrid *volatile oil*, an alkaloid, a phenolic compound termed xanthoxylin, etc.

**Uses.**—Stimulant and sialagogue. The bark is chewed for the relief of toothache.

**Average Dose.**—2 Gm. (30 grains).

**Adulterant.**—Prickly Ash bark has been both adulterated with and substituted by the bark of *Aralia spinosa*, commonly known as Hercules Club. This can readily be detected by the presence of numerous sharp spines on its outer surface that are not mounted on corky cones, by its non-lignified cork, distinct schizogenous reservoirs and numerous rosette aggregate crystals of calcium oxalate.

**Preparations** (unof.).—Fluidextractum Xanthoxyli, 2 cc.; Elixir Hydrastis Compositum (from Fld. Ext.), 4 cc.

**Allied Drug.**—Xanthoxylum Fruit or Prickly Ash Berries consist of the dried, full-grown ripe fruit of *Zanthoxylum americanum* Miller (Northern Prickly Ash) and *Zanthoxylum Clava-Herculis* Linné (Southern Prickly Ash). They consist of ellipsoidal follicles up to 6 mm. in length containing 1 to 2 oblong,

black, shiny seeds. When crushed and moistened they possess an aromatic odor resembling citral. Their taste is warmly aromatic and pungent. They contain a volatile oil with citral, hesperidin, etc. They are used as a stimulant, diaphoretic and tonic.

#### SWEET ORANGE PEEL U.S.P. (AURANTII DULCIS CORTEX)

**Synonyms.**—Orange Peel; *Fr.* Écorce d'Oranges douces; *Ger.* Apfelsinschalen.

**Botanical Origin.**—*Citrus sinensis* (Linné) Osbeck.

**Part Used.**—The fresh outer rind of the non-artificially colored ripe fruit.

**Habitat.**—Northern India. Cultivated in Florida, California and Brazil.

**Plant.**—*Citrus sinensis* (*Citrus Aurantium* L. var. *sinensis* L.) is a blunt spiny tree of medium height with leaves varying through the lighter shades of green, having an acuminate apex and a broadly winged petiole. Flowers are fragrant, white, axillary, with 20–24 stamens and a globose ovary. Fruit is a hesperidium, from  $2\frac{3}{4}$ – $3\frac{1}{4}$  inches in diameter with hollow core, acid pulp and tight skin.

**Description.**—The outer, orange-yellow layer separated from fresh orange fruit by grating or paring and consisting of epidermal cells, parenchyma cells of the sarcocarp with chromoplastids, oil reservoirs and globules of volatile oil; odor fragrant; taste pungently aromatic. The inner white portion of the rind must be excluded.

**Constituents.**—*Volatile oil* containing about 90 per cent of *d-limonene*; *decyl aldehyde*, *linalool*, and the *methyl ester of anthranilic acid*; the flavanone glycoside *hesperidin*, etc.

**Uses.**—Flavoring agent. Hesperidin is used in treating disorders caused by abnormal capillary fragility and is believed to be a precursor of vitamin P, if not the vitamin itself.

**Preparations.**—U.S.P.: Sweet Orange Peel Tincture; Orange Syrup (from Tr.). N.F.: Glycerinated Gentian Elixir (from Tr.), Terpin Hydrate Elixir (from Tr.), 4 cc. (1 fl. dr.), Pentobarbital Elixir (from Tr.), 4 cc. (1 fl. dr.).

#### ORANGE OIL U.S.P. (OLEUM AURANTII)

Orange Oil or *Sweet Orange Oil* is a volatile oil obtained by expression from the fresh peel of the ripe fruit of *Citrus sinensis* (Linné) Osbeck (Fam. *Rutaceæ*). It should not be dispensed if it has a terebinthinate odor.

**Description.**—Orange oil is a yellow or orange liquid having the characteristic odor and taste of the outer part of sweet orange peel; sp. gr. 0.842–0.846; opt. rot. +94° to +99° in a 100 mm. tube at 25°C.; ref. ind., 1.4723 to 1.4737 at 20°C.

**Production.**—Oil of Orange is produced in California and Florida. The California product has a fine fruity flavor suggestive of both orange juice and peel. The Italian oil possesses a strong peel-like note. Some supplies have also been imported from Italy, France, Jamaica, Brazil, and Africa.



**Uses.**—Stimulant, aromatic, and flavoring agent in pharmaceuticals, soft drink extracts, confectionery, bakery products, etc. Average Dose, 0.1 cc. (1½ minims).

**Preparations.**—U.S.P.: Compound Orange Spirit, Aromatic Elixir. N.F.: Compound Cardamom Spirit, Compound Cardamom Elixir (from Comp. Orange Spt.), Iron, Quinine and Strychnine Elixir (from Comp. Orange Spt.). Iron, Quinine and Strychnine Phosphates Elixir, Compound Serenoa and Sandalwood Elixir (from Comp. Orange Spt.), Compound Myrcia Spirit.

### BITTER ORANGE PEEL U.S.P. (AURANTII AMARI CORTEX)

**Synonyms.**—Seville Orange Peel, Wild Orange Peel, Curaçao Orange Peel; *Fr.* Écorce d'Oranges amères; *Ger.* Pomeranzenschale.

**Botanical Origin.**—*Citrus Aurantium* Linné (*Citrus vulgaris* Risso).

**Part Used.**—The dried rind of the unripe fruit.

**Habitat.**—Northern India. Cultivated widely in the subtropics.

**Plant.**—A small tree attaining a height of about 10 or 15 feet and possessing greenish-brown bark, fragrant, evergreen, ovate, pellucid-punctate leaves and white flowers. The fruit is round, rough-skinned, from 2 to 3¼ in. in diameter and contains a bitter, acid pulp.

**Production and Commerce.**—The green fruit is collected chiefly in Mediterranean countries, the rind removed, cut into quarters or strips and dried. The commercial supplies come chiefly from Sicily, Malta and Spain.

**Description.**—In irregular bands (ribbons) or elliptical, somewhat curved, acutely pointed pieces (quarters), from 3 to 6 cm. in length and from 2 to 6 mm. in thickness, and with recurved edges; outer surface weak brown to moderate olive, roughened from fine reticulate ridges and with numerous, minute pits; inner surface weak yellow to weak greenish yellow, with many slight, conical projections and linear, anastomosing lines formed by the vascular bundles; fracture hard, short; odor fragrant and aromatic; taste aromatic and bitter.

**Histology.**—1. Outer epidermis (epicarp) of small angular cells.

2. Mesocarp, composed of (1) outer region of thick-walled cells, some containing chloroplastids or chromoplastids, others membrane crystals of calcium oxalate, the latter up to 45μ in length. Arranged in two irregular rows within this zone are large shizolysigenous oil reservoirs; (2) a broader inner region of branching spongy parenchyma cells surrounding intercellular-air-spaces. Through this region course anastomosing vascular bundles.

**Powdered Drug.**—Weak yellow to weak greenish yellow; numerous fragments of parenchyma whose cell walls are from 4 to 12μ thick; tracheæ small with close spiral thickenings or simple pores; prismatic crystals of calcium oxalate up to 45μ in length.

**Constituents.**—Volatile oil, the glycosides *aurantiin* (*naringin*), *aurantiamarin* and *isohesperidin*; *aurantiamaric acid*, calcium oxalate, *pectin*, etc.

**Preparations.**—Bitter Orange Peel Tincture U.S.P., 4 cc., Compound Cinchona Tincture N.F., 4 cc., Compound Gentian Tincture U.S.P., 4 cc.

**Uses.**—Aromatic bitter and flavoring agent.

**Average Dose.**—1 Gm. (15 grains):

**Bitter Orange Oil** (*Oleum Aurantii Amari*) N.F. or Oil of Bitter Orange is a pale yellow or yellowish-brown volatile oil obtained by expression from the fresh peel of the fruit of the Curaçao orange, *Citrus Aurantium* L. Stimulant, aromatic. Average dose, 0.1 cc. (1½ minims). Preparation, Bitter Orange Elixir (Elixir Curassao).

**Orange Flower Oil** (*Oleum Aurantii Floris*) N.F. or *Neroli Oil* is a slightly fluorescent volatile oil possessing a pale yellow color and distinctive fragrant odor distilled from the fresh flowers of the bitter orange (*Citrus Aurantium* L.). This oil becomes reddish brown on exposure to light and air. In alcoholic solution it exhibits a violet fluorescence. The oil is largely produced in Southern France by distillation in steam stills. The stills, holding about 700 liters, are charged with 250 to 300 kilos of fresh flowers and 1½ times the amount of water is added. About one gram of neroli oil and one kilo of orange flower oil are obtained from one kilo of orange flowers. Orange Flower Oil is also produced by extraction with volatile solvents. Used as a perfume in cologne water, cosmetics, etc.

#### LEMON PEEL U.S.P. (LIMONIS CORTEX)

**Synonyms.**—*Fr.* Écorce de Limon; *Ger.* Limonenschale.

**Botanical Origin.**—*Citrus Limon* (L.) Burmann filius.

**Part Used.**—The outer yellow rind of the fresh ripe fruit.

**Habitat.**—Northern India. Cultivated in Italy, Sicily, Spain, Portugal, California, etc.

**Plant.**—A small, unevenly branched tree with stiff, short thorns and ovate, serrate, green leaves whose wingless petioles may have narrow margins. Flowers solitary or in clusters. The petals are white above and reddish-purple below. The stamens are from 20 to 40. The fruit is oval or oval-oblong, yellow, and has an acid pulp. An apical papilla is prominent. Seeds small and smooth.

**Description.**—The outer, lemon yellow or dark yellow layer, separated from the fresh fruit by grating or paring, and consisting of the epidermis, numerous parenchyma cells containing yellow chromoplastids, and large oil reservoirs with globules of the volatile oil; odor fragrant, distinctive; taste aromatic.

**Histology.**—The epidermis is composed of small tabular cells. The hypoderm contains numerous chromoplastids. The mesocarp has colorless, thin-walled parenchyma and large, elliptical schizolysigenous oil reservoirs; parenchyma cells contain a layer of granular protoplasm adhering to the walls and occasionally membrane crystals of calcium oxalate which are irregularly polygonal, 15 to 25μ in diameter.

**Constituents.**—*Volatile oil*, containing *d-limonine*, *citral*, *citronellal*, *geranyl acetate*, *terpineol*, methyl heptenone and a sesquiterpene; *hesperidin*, etc.

**Use.**—Flavoring agent, stimulant and aromatic.

**Preparation.**—Lemon Tincture, U.S.P. which enters into Syrup of Citric Acid.

## LEMON OIL U.S.P. (OLEUM LIMONIS)

Oil of Lemon or Lemon Oil is the volatile obtained by cold expression from the fresh peel of the fruit of *Citrus Limon* (L.) Burmann filius with or without the previous separation of the pulp and the peel. It is a yellow or greenish yellow liquid having the odor and taste of the outer part of fresh lemon peel; sp. gr., 0.849 to 0.855; opt. rot.,  $+57^{\circ}$  to  $+65.6^{\circ}$  in a 100 mm. tube; ref. ind. 1.4740 to 1.4755 at  $20^{\circ}\text{C}$ .

Most of the oil of lemon used in this country is machine-produced and comes from California. Some hand pressed oil has been imported from Italy. It should not be dispensed if it has a terebinthinate odor.

**Constituents.**—About 90 per cent of *d-limonene*, about 3.5 to 7.5 per cent. of *citral*, small amounts of pinene, camphene, phellandrene and  $\gamma$ -terpinene, 2 per cent. of a solid substance termed citraptene or lemon camphor, etc. Aromatic, stimulant and flavoring agent.

**Average Dose.**—0.1 cc. ( $1\frac{1}{2}$  minims).

**Preparations.**—Compound Orange Spirit, U.S.P. which enters into Aromatic Elixir, U.S.P., Cologne Water, N.F., Magnesium Citrate Solution, U.S.P., Aromatic Eriodictyon Syrup, N.F., Aromatic Ammonia Spirit, U.S.P., St. John Long's Liniment, N.F.

## BERGAMOT OIL N.F. (OLEUM BERGAMOTTÆ)

Bergamot oil is a volatile oil obtained by expression from the rind of the fresh fruit of *Citrus Bergamia* Risso et Poiteau, a small tree with oblong oval leaves having long, winged petioles, white flowers and pyriform, pale yellow fruits. The oil should yield not less than 36 per cent. of esters calculated as linalyl acetate,  $\text{C}_{10}\text{H}_{17}\text{C}_2\text{H}_3\text{O}_2$ .

The tree is extensively cultivated in the Province of Reggio Calabria for the fragrant volatile oil. Here cions of bergamot are grafted on bitter orange stock. The volatile oil is extracted by grating the fruit between two corrugated discs, one fixed, the other rotating. This grinds off the outer epicarp of the peel, breaking the oil cavities and liberating the oil and some water. The resultant pasty mass is placed in sacs and expressed in a conical apparatus. The expressed mixture of oil and water is allowed to stand and the supernatant oil decanted. The marc remaining in the sacs is sometimes distilled with steam and yields an inferior oil. Bergamot oil is green to greenish-yellow or yellowish-brown, has a characteristic fragrant odor and an aromatic bitter taste, is dextrorotatory, and has a sp. gr. of 0.875 to 0.880 at  $25^{\circ}\text{C}$ . It is used in the preparation of Perfumed Spirit, N.F. and in the perfume and cosmetic industries.

## PECTIN N.F. (PECTINUM)

**Definition.**—A purified carbohydrate product obtained from the dilute acid extract of the inner portion of the rind of citrus fruits, or from apple pomace. It consists chiefly of partially methoxylated polygalacturonic acids.

**Purity Rubric.**—Pectin yields not less than 7 per cent. of methoxyl groups and not less than 78 per cent. of galacturonic acid when calculated on a moisture and ash free basis. It also yields not more than 4 per cent. of total ash, not more than 0.4 per cent. of acid-insoluble ash, and not more than 10 per cent. of moisture.

**Description.**—An almost odorless, coarse or fine, yellowish-white powder with a mucilaginous taste. It is nearly completely soluble in 20 parts of water at 25°C., forming a viscous, opalescent, colloidal solution which flows readily and is acid to litmus paper. It dissolves in water more readily if first moistened with alcohol, glycerin, or simple syrup, or if first mixed with 3 or more parts of sugar. It is insoluble in alcohol or other organic solvents.

**Identity Tests.**—When 1 Gm. of pectin is heated on a water bath with 9 cc. of water, replacing the water lost by evaporation, a solution is formed which yields a stiff gel on cooling.

A 1 in 100 aqueous solution of pectin, when treated with an equal volume of alcohol, yields a translucent gelatinous precipitate (difference from most gums).

To 10 cc. of an aqueous solution of pectin (1 in 100) add 1 cc. of thorium nitrate T.S., stir and allow to stand for 2 minutes: a stable precipitate or gel forms (difference from gums).

**Uses.**—As an emulsifying and gelling agent; in pharmaceutical and cosmetic products such as pastes for external application, hair pomades, dentifrices, etc.

**N.F. Preparations.**—Pectin Paste, Thin Pectin Paste.

**Adulterants.**—Gums, starch, sugars, tragacanth, organic acids.

#### SIMARUBACEÆ (AILANTHUS FAMILY)

A family of chiefly shrubs or trees containing bitter principles. The leaves are alternate and pinnate. The flowers are dioecious or polygamous and arranged in axillary panicles (*Picrasma excelsa*) or racemes (*Quassia amara*). The plants are distinguished from those of the *Rutaceæ* by the absence of secretory cavities.

#### QUASSIA N.F. (QUASSIA)

**Synonyms.**—*Bitter Wood*, Bitter Ash, Lofty Quassia; *Fr.* Bois de Quassie; *Ger.* Lignum Quassiae, Quassienholz.

**Botanical Origin.**—(1) *Picrasma excelsa* (Swartz) Planchon and (2) *Quassia amara* L.

**Part Used.**—The heartwood.

**Purity Rubric.**—Not more than 1 per cent. of foreign organic matter; it yields not more than 0.5 per cent. of acid-insoluble ash.

**Habitat.**—(1) West Indies; (2) Northern South America.

**Plants.**—*Picrasma excelsa* is a tree attaining the height of 24 m. with a trunk diameter of from .5 to 1 m. with grayish-brown, wrinkled bark and spreading branches. The leaves are imparipinnate with 9-17 ovate petiolate leaflets. The flowers are small, yellowish-green and borne in axillary panicles. The fruit is a small black drupe. *Quassia amara* varies from a shrub to a tree with spreading branches that bear 4-5 narrow obovate leaflets. The flowers

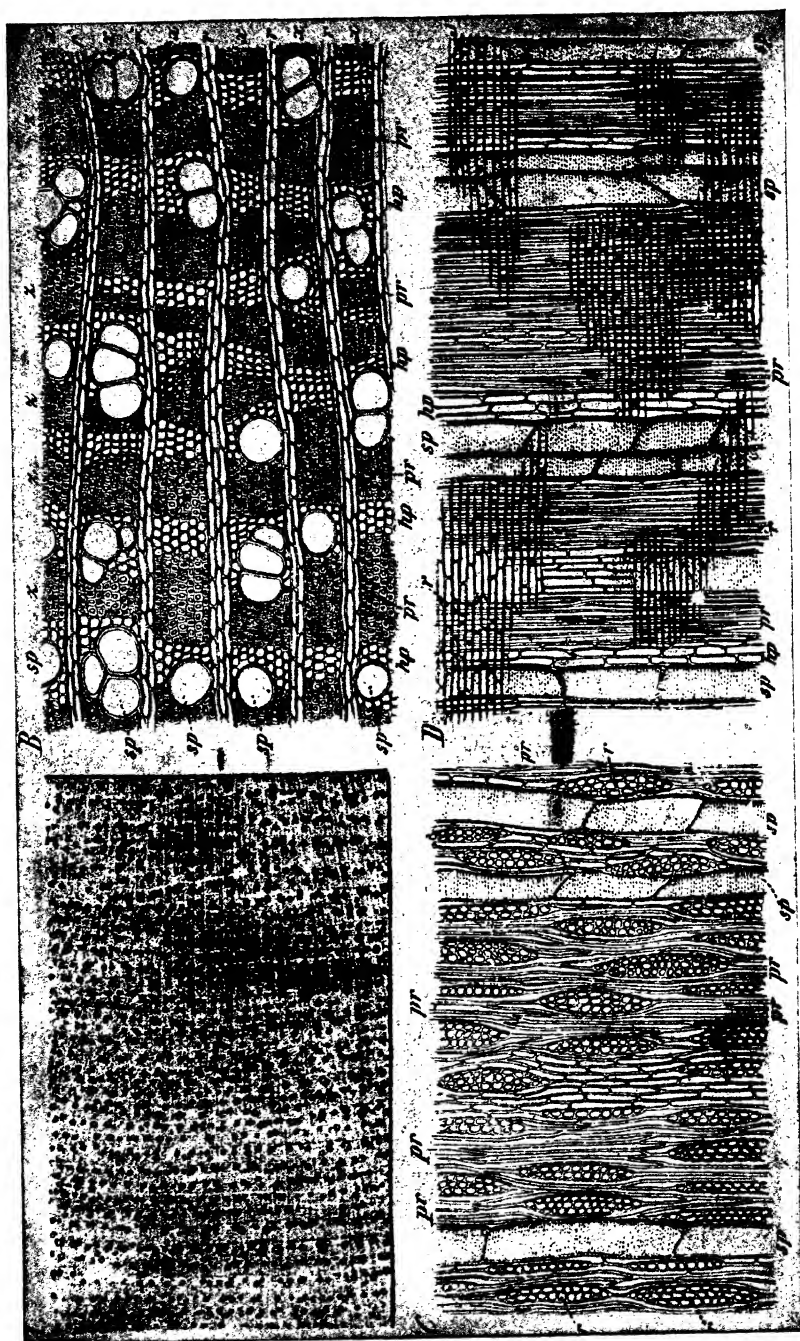


FIG. 246.—Jamaica Quassia. A, cross section of wood  $\times 3$ . B, cross section of wood,  $\times 65$ . C, tangential-longitudinal section of wood,  $\times 65$ . D, radial-longitudinal section of wood,  $\times 65$ . Wood parenchyma, *hp*; wood fibers, *pr*; tracheæ, *sp*; medullary rays, *r*, separating xylem patches, *x*. (After Berg.)

are bright red and borne in terminal racemes. The fruit is a 5 chambered pod.

**Production and Commerce.**—There are two commercial varieties viz.: Jamaica from *Picrasma excelsa* and Surinam from *Quassia amara*. Jamaica Quassia is imported from Kingston and St. Ann's Bay, Jamaica, in the form of logs sawed from the trunk and thicker branches. It has been also imported in the cut form from Hamburg and London.

## JAMAICA

Usually in yellow chips, shavings or raspings, occasionally in billets; fracture tough, fibrous.

Odor slight; taste very bitter.

**Microscopical Characteristics**

Tracheæ comparatively broad, usually in groups of 2-6, occasionally single and surrounded by numerous wood fibers.

Medullary rays lignified, 1-5 cells wide and 10-20 rows deep.

Calcium oxalate in tetragonal or hexagonal prisms, abundant in medullary rays.

Parenchyma lignified and in interrupted tangential bands.

## SURINAM

Occurs similarly but billets usually thinner. Fracture tough, fibrous.

Odor and taste similar.

Tracheæ narrower, single or in pairs, occasionally in groups of 3 or 4.

Medullary rays lignified, 1-4 cells wide (mostly 1-2 cells wide) and 10-30 rows deep.

Calcium oxalate crystals few or entirely absent.

Parenchyma similar.

**Powdered Drug.**—Weak yellow; fragments of tracheæ with numerous small bordered pores; wood fibers numerous with thin walls and oblique pores; lignified medullary ray cells and parenchyma cells with numerous pores; calcium oxalate in 4- to 6-sided prisms, from 6 to  $30\mu$  in length, isolated or in crystal fibers; starch grains few, spherical or ellipsoidal and from  $5\mu$  to  $15\mu$  in diameter.

**Constituents.**—Jamaica Quassia contains the bitter active principles  $\alpha$ -picrasmin and  $\beta$ -picrasmin, etc. Surinam Quassia contains quassins.

**Uses.**—Quassia is employed in the form of an infusion as a bitter tonic and as a rectal injection for thread worms in children.

**Average Dose.**—0.5 Gm. ( $7\frac{1}{2}$  grains).

**BURSERACEÆ (MYRRH FAMILY)**

Shrubs and trees of tropical climes having schizogenous secretion reservoirs in their bark which contain gum, resin, and oil. Leaves alternate and compound. Flowers small, regular and hermaphrodite, arranged in racemes or panicles. Fruit a drupe.

**MYRRH U.S.P. (MYRRHA)**

**Synonyms.**—*Gum Myrrh*; *Fr. Myrrhe*; *Ger. Myrrhe*.

**History.**—Myrrh has been used as an incense, perfume and medicine from remote antiquity. It is mentioned in The Old and New Testaments and some form of it was used by the ancient Hebrews and Arabs as a gift (probably the gum resin from *C. erythraea* var. *glabrescens* or Bissabol). It is cited in *Herodotus* as one of the substances used by the Egyptians in embalming the dead. In

the bazaars of India, it is still known as "Heerabol" and the Somalis know it as "Mulmul."

**Botanical Origin.**—*Commiphora molmol* Engler, *Commiphora abyssinica* (Berg) Engler or other species of *Commiphora*.

**Part Used.**—An oleo-gum-resin.

**Standard of Assay.**—Not less than 30 per cent. of alcohol-soluble extractive.

**Limit of Impurities.**—Not more than 5 per cent. of acid-insoluble ash. (Total ash, 5 to 13.4 per cent.)

**Habitat.**—Northeastern Africa and Arabia.

**Plants.**—The genus *Commiphora* contains over 60 species. One of these, *Commiphora molmol* Engler [*C. Myrrha* (Ness) Baillon], is a small tree which is claimed by Engler and Tschirch to yield Somali Myrrh. Deflers and Scheinfurth ascribe the source of the drug to *C. abyssinica*. Several species of *Commiphora* yield the drug, especially *C. molmol* which grows in Somaliland and *C. abyssinica* and *C. Schimperi* which grow in Arabia and Northern Abyssinia in which places the drug is largely gathered. The plants are trees with whitish-gray bark and rough, stunted, spiny branches, trifoliate leaves, dioecious flowers and oval-lanceolate, drupaceous fruits.

**Production and Commerce.**—The trees grow in forests in the Red Sea districts of northeast Africa (Somaliland) and western Arabia. The gum-oleo-resin, which is at first yellowish-white is formed in schizogenous secretion reservoirs in the bark and pith. The tissue between these reservoirs frequently disintegrates forming lysigenous cavities which, with the schizogenous cavities, become filled with a granular gum-resin. It exudes spontaneously through natural fissures in the bark and through induced incisions. After hardening it becomes brownish-yellow to reddish-brown and is collected. There are three commercial varieties—African or Somali Myrrh, Arabian or Fadhli Myrrh and Yemen Myrrh. *African Myrrh* is considered the best variety. It is the most aromatic, and exhibits an unctuous, granular surface, often with whitish striae or spots, when fractured. It is sent from Somaliland to British East African ports and to Aden for shipment to the world's markets. *Arabian Myrrh* is less aromatic and has a less dusty appearance than the African variety and is devoid of whitish markings internally. *Yemen Myrrh* is the least aromatic. It occurs in large masses of a dark reddish-brown color which, when fractured, are devoid of an oily surface and whitish markings. It is shipped from Makulalah, Arabia to Aden and Bombay. The commercial supplies of Myrrh are shipped chiefly from British East Africa, Aden, Arabia, and from Bombay, India to Europe and America. In 1947, this country imported 63,886 lbs. of the drug from British Somaliland and India.

**Description.**—It occurs in moderate yellow to dark- or reddish-brown rounded or irregular masses or tears more or less covered with a lighter colored yellowish or brownish-yellow dust; fracture waxy, granular, conchoidal; the internal surface yellowish or reddish-brown, sometimes marked with white lines or spots; odor aromatic, balsamic, not terebinthinate; taste aromatic, bitter and acrid.

**Identity Tests.**—Myrrh gives a purplish to violet color with nitric acid (distinction from Bdelliums). It yields a yellowish-brown emulsion when triturated with water (distinction from other gum resins). An ethereal solution of Myrrh treated with bromine vapor becomes reddish-violet (distinction from Bissabol).

**Constituents.**—From 2.5 to 9 per cent. of a yellow *volatile oil*, possessing the odor of the drug and containing cuminol, pinene, eugenol, meta-cresol, dipentene and two sesquiterpenes; from 25 to 45 per cent. of *resin; gum, bitter principle*, etc. The resin consists of 3 free resin acids ( $\alpha$ -,  $\beta$ -, and  $\gamma$ -commi-

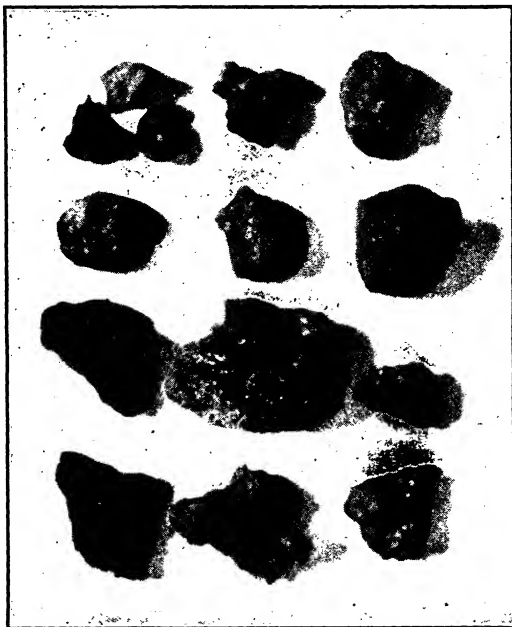


FIG. 247.—Myrrh. Note the masses and tears of variable size.

phorinic acids), a combined resin-acid (commiphorinic acid) and 2 phenolic resins, insoluble in ether, also  $\alpha$ - and  $\beta$ -myrrhoidic acids (soluble in ether). The gum, representing 50 to 60 per cent. of the drug, consists of water-soluble *arabin*.

**Uses.**—Myrrh is used in antiseptic mouthwash preparations, as an emmenagogue, stimulant tonic and as an application to sore gums, also as an incense and in perfumery.

**Average Dose** (unof.).—0.5 Gm. ( $7\frac{1}{2}$  grains).

**Preparations.**—Myrrh Tincture, U.S.P., 2 cc. (30 minims).

**Adulterants.**—(1) Gum resins from other species of *Commiphora*, notably the Bdelliums. These do not take a purple or violet color with nitric acid. (2) *Bissabol*, also called Perfumed bdellium, Scented bdellium and East Indian Myrrh, is probably obtained from *Commiphora erythæa* var. *glabrescens*. This occurs as lumps or tears which are yellowish, with a waxy, oily fracture and



showing whitish lines crossed by angular spaces containing a brown resin. It is more aromatic in odor and less bitter but more acrid than official Myrrh. An ethereal solution does not become reddish with bromine vapor. (3) *Opaque Bdellium*, a hard, opaque, yellowish-brown, gum-resin often containing paper bark fragments and possessing a faint cedar-like odor and a bitter taste. It occurs in rounded pieces from 1 to 1½ in. in diameter. (4) *African Bdellium*, occurring in yellowish-brown to grayish-brown rounded masses which are red by transmitted light and possess a peppery odor and a bitter, slightly acrid taste. (5) *Indian Bdellium*, in large dark reddish-brown, irregular masses adhering to the teeth when chewed, the outer and fractured surface dotted with shiny points of resin. Its odor is faint, cedar-like, its taste acrid. (6) Gums. (7) Sand. (8) Vegetable fragments.

#### OLIBANUM

**Synonyms.**—Frankincense, Thus; *Ger.* Weihrauch; *Fr.* Encens.

**Botanical Origin.**—*Boswellia Carterii* Birdwood and other species of *Boswellia*.

**Part Used.**—The gum resin.

**Habitat.**—Somaliland and Arabia.

**Plants.**—Small trees containing schizogenous, gum-oleoresin reservoirs in their bark.

**Production and Commerce.**—The bark is incised by natives of Arabia, Somaliland and the Sudan, and the exudation, in tears or masses, is gathered after it has dried. A large amount of the Arabian drug is carried to Aden and shipped to Bombay, India, from whence it is exported to various parts of the world. British Somaliland also produces Frankincense in considerable amounts, and lesser amounts are gathered in the Anglo-Egyptian Sudan.

**Description.**—In pale yellowish, ovoid, oblong, pyriform, clavate, or stalactite-shaped tears, often tinged with blue, green or red with a dull surface and usually covered with a whitish dust, or in dull reddish masses often containing bark fragments; fracture brittle, exhibiting a dull and waxy fractured surface; internally opalescent and waxy; odor characteristically aromatic; taste aromatic and slightly bitter.

When triturated with water a milky emulsion is formed; when chewed the tears soften to plastic masses.

**Constituents.**—60 to 70 per cent. of resins composed of free and combined *boswellic acid* and *olibanoresin*; 5 to 7 per cent. of *volatile oil* containing *l*-pinene, dipentene and phellandrene and 27 to 35 per cent. of *gum*, the latter containing arabin and bassorin.

**Uses.**—As an incense and in fumigating pastilles and plasters; stimulant.

#### MELIACEÆ (MAHOGANY FAMILY)

Tropical trees or shrubs with wood often hard, colored and odoriferous. Leaves alternate, exstipulate, pinnately-compound, rarely simple and entire. Inflorescence a terminal or axillary raceme. Flowers hermaphrodite or rarely polygamo-dicæcious, regular; sepals five to four, small; petals usually five to

four, hypogynous; stamens generally ten to eight rarely five, very rarely twenty to sixteen, inserted outside the base of the hypogynous disc; filaments united into a tube; carpels usually five to three; style simple; ovary free, usually five- to three-celled. Fruit a drupe (*Melia*), berry (*Vavaea*), or capsule (*Cedrella*). Seeds exalbuminous or with fleshy albumen.

#### COCILLANA (COCILLANA)

**Synonyms.**—Cocillana Bark, Guapi Bark, Huapi Bark, Trompillo.

**History.**—Cocillana bark was long used by the natives of the Bolivian Andes as an emeto-cathartic. It was introduced into medicine in this country by Dr. H. H. Rusby who, in 1886, collected it at Guanai, on the Mapiri River.

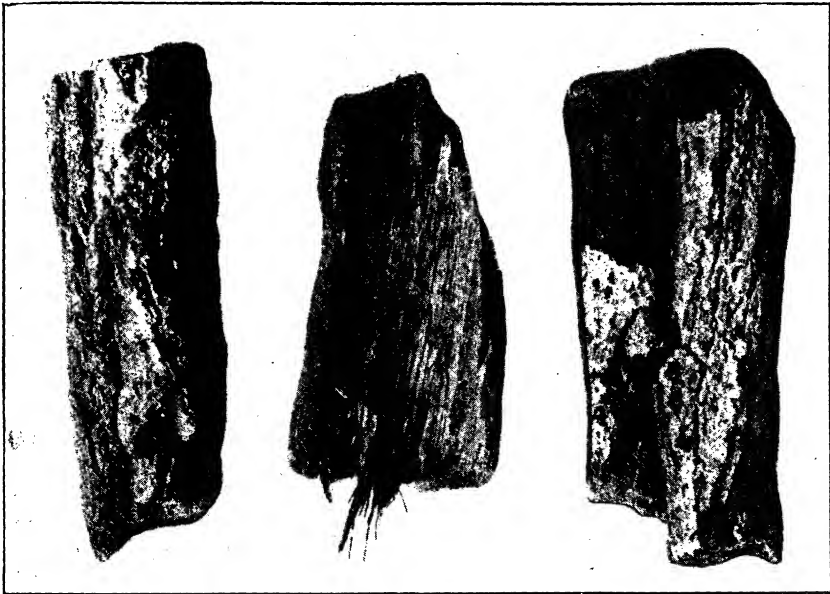


FIG. 248.—Cocillana bark. Outer surface of two pieces is shown on right and left, while inner surface aspect appears in central piece.

**Botanical Origin.**—*Guarea Rusbyi* (Britton) Rusby.

**Part Used.**—The dried bark.

**Purity Rubric.**—Not more than 5 per cent. of wood or other foreign organic matter (N.F. V).

**Habitat.**—Bolivia, along the eastern slope of the Andes Mts.

**Plant.**—A tree with paripinnate leaves and pyriform to spheroidal fruits.

**Description.**—In flat or curved pieces up to 2 cm. thick and of variable length and width; outer surface fissured, grayish-brown or gray from adherent lichens, frequently abraded in spots and then orange-brown; inner surface brown, coarsely and irregularly longitudinally striate; fracture of outer bark short, of inner bark splintery-fibrous and soft; odor characteristic; taste astringent and slightly nauseous.

**Histology.**—The outer bark exhibits one or more zones of cork alternating with cortical parenchyma containing groups of stone cells and some isolated stone cells. The middle bark shows a matrix of starch-parenchyma scattered within which are groups of thick-walled stone cells and bundles of sclerenchyma fibers with accompanying crystal fibers. The inner bark shows large groups of bast fibers surrounded by crystal fibers which contain monoclinic prisms of calcium oxalate and separated tangentially by phloem parenchyma and sieve tissue and radially by wavy medullary rays, 1 to 3 cells in width. The medullary ray cells frequently possess lignified walls and contain either starch or reddish amorphous masses. Secretory cells with a yellowish-white, granular, caoutchouc-like content occur in the parenchymatous regions.

**Powdered Drug.**—Light brown; numerous groups of lignified sclerenchyma fibers having pointed ends, some showing accompanying crystal fibers containing monoclinic prisms of calcium oxalate, the latter up to  $25\mu$  in length; fragments of parenchyma and medullary-rays with reddish-brown contents or starch grains; numerous angular or irregular stone cells with thick, yellowish, lamellated and porous walls, up to  $150\mu$  in length; numerous single, spheroidal or 2- to 4-compound starch grains, the individual grains up to  $20\mu$  in diameter; fragments of dark brown cork.

**Constituents.**—The alkaloid *rusbyine*, 2.5 per cent. of resins, a caoutchouc-like substance, fixed oil, tannin, etc.

**Use.**—Cocillana is used as a nauseating expectorant usually in the form of a syrup or fluidextract. In large doses it is an emetic.

**Average Dose.**—1 Gm. (15 grains).

**Adulterant.**—The bark of *Guarea Bangii* Rusby which is not over 5 mm. thick, having a cork with a reddish cast and a tougher and considerably more fibrous fracture than genuine Cocillana and shows projecting splinters throughout the entire bark. Its odor is indistinct and its taste slightly astringent. Cross sections show narrow bands of bast fibers, 1 to 2 cells broad extending between the medullary-rays. The powdered bark is light chocolate brown and contains starch grains up to  $8\mu$ , fewer crystals and smaller stone cells than the authentic article.

#### POLYGALACEÆ (MILKWORT FAMILY)

Herbs or shrubs with upright, herbaceous or woody stems often branching profusely, the branches occasionally becoming geotropic or subterranean and bearing cleistogamous flowers. Leaves simple, often lanceolate or linear, exstipulate, alternate. Inflorescence a raceme, spike (*Polygala Senega*) or head (*P. lutea*). Flowers irregular, hermaphroditic with commonly eight stamens. Fruit a two-celled capsule (*P. Senega*), rarely a drupe or samara. Pollen grains barrel-shaped.

#### SENEGA N.F. (SENEGA)

**Synonyms.**—*Seneca-snakeroot*, Senega Snakeroot, Rattlesnake Root, Mountain Flax; *Ger.* Senegawurzel; *Fr.* Polygala de Virginie.

**Botanical Origin.**—*Polygala Senega* Linné.

**Part Used.**—The dried root.

**Purity Rubric.**—Not more than 5 per cent. of attached stem bases and not more than 2 per cent. of other foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—In woods and rocky soil of Southern Canada and Eastern United States as far south as South Carolina and west to Wisconsin, Minnesota and Missouri.

**Plant.**—A perennial herb whose underground portion consists of a conical, twisted, branched yellow root with a knotty crown. The larger roots are marked with cross lines (knurled), which are due to regions of greater or lesser diameter in the root forming a series of bulges. The aerial portion consists of several erect or ascending, smooth stems arising to the height of 1.5 to 3 dm. and bearing alternate, sessile, lanceolate or oblong-lanceolate, bright green leaves with rough margins. The inflorescence consists of a close spike of small, white flowers that differ from some of the *Polygalas* in being chasmogamous. The fruit is a small, loculicidally dehiscent, 2-celled capsule containing 2 black seeds, each of which has a caruncle of about the same length as the seed.

**Production and Commerce.**—There are two commercial varieties of this drug e.g., Northern and Southern Senega. The Northern Senega is collected mainly in the province of Manitoba and in Minnesota; the Southern, mainly from Virginia to Texas. The root should be dug in autumn, cleaned and carefully dried. The commercial supplies used in the United States come mainly from Saskatchewan, Canada, Minnesota, Georgia and South Carolina.

**Description.**—This drug occurs as a mixture of entire, conical, more or less tortuous and branched roots and broken pieces thereof together with detached rootlets; when entire the roots are up to 8 cm. (Southern Senega) or 15 cm. (Northern Senega) in length and up to 7 mm. (Southern Senega) or 12 mm. (Northern Senega) in thickness; externally weak brown to weak yellowish orange, purplish near crown (Northern Senega); the crown being knotty and composed largely of short stem bases and numerous rose tinted or purple buds which give it a rose-red or purple color, the rest of the main root longitudinally wrinkled, knurled and frequently marked by a distinct ridge or



FIG. 249.—*Polygala Senega*.

keel; fracture short, wood pale yellowish orange to yellowish white, usually eccentrically developed; odor peculiar, methyl salicylate like, taste sweetish; afterward strongly acrid. As has been shown by Carpenter, a characteristic raised ridge, running longitudinally and somewhat spirally follows the twisting on larger roots. When the roots are dried this ridge forms the *keel*. It develops along that portion of the root free from cross wrinkles. The keel is linear and uniform in shape and size.



FIG. 250.—Senega. Note the multiple crown and keel.  $\times \frac{3}{4}$ .

**Histology.**—Transverse sections of the root, cut through the keel region, show the following microscopic peculiarities: An eccentric development of wood, the lignified portion of the central xylem cylinder varying in outline from circular, elliptical, ovate, reniform or semicircular to irregularly fan-shaped or even separated by broad parenchyma rays (medullary rays) into 2 or more masses and being surrounded by cambium and an unevenly developed phloem and cortex, the phloem and cortex being usually thickest next to the broadest strands of lignified wood, and where the wood-wedges are shorter or absent and the parenchyma rays very broad, the cortex and phloem usually occupy a proportionately narrower zone of the cross-section.

Transverse sections of older portions of roots show (1) a *corky layer* of from 4

to 5 rows of tangentially-elongated, brown to orange colored cells; (2) an indistinct *phellogen* seen only here and there; (3) *secondary cortex* of about 20 rows of parenchyma cells on one side of the root and only 10 or less on the other, the cells having slightly thickened walls and containing a colorless or pale yellow, amorphous substance, which is liberated in the form of large globules on

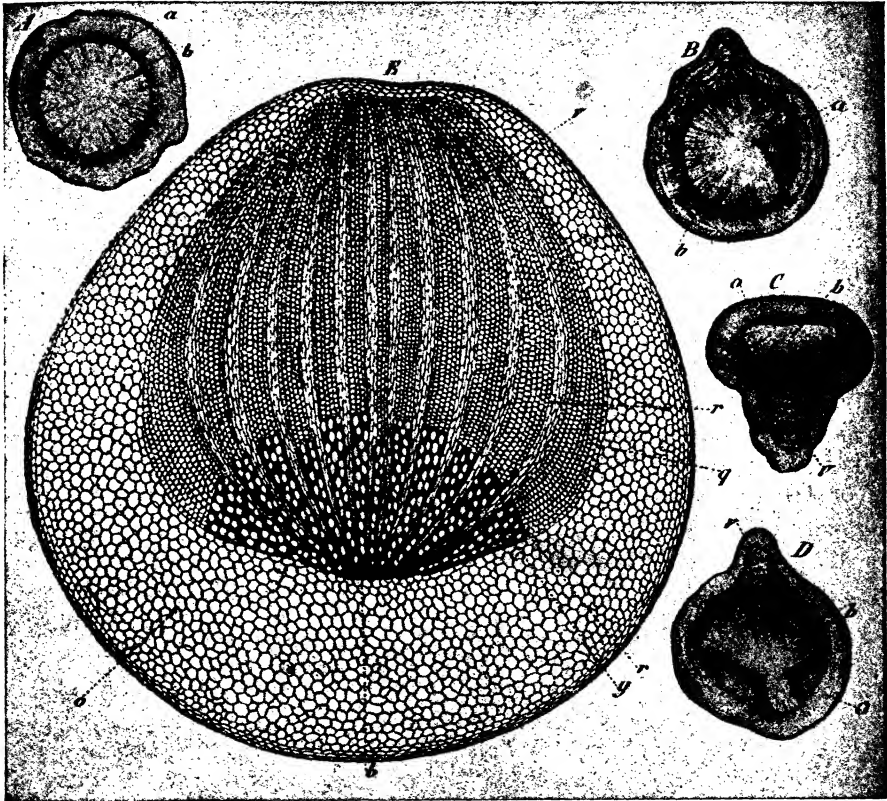


FIG. 251.—*Senega*. A, B, C, D, Transverse sections through *Senega* root at different levels showing the characteristic variation of the cortex, phloem and wood. A, normal structure above keel. B, C, D, E, sections through keel at different levels. E, Transverse section through the keel portion of a root approaching that of Fig. C, in conformation,  $\times 60$ . The phloem, extending out from the half circle of xylem, has pressed as a blunt cone into the keel and has crowded out the cortex which is alone completely developed on the opposite side. a, bark; b, lignified area of wood; o, cortex; r, medullary rays; g, phloem; w, cambium; y, xylem. (After Berg.)

the addition of a drop of potassium hydroxide T.S.; (4) a *phloem* or inner bark, the cells in radial rows, consisting of parenchyma, small groups of sieve tissue in inner portion adjacent to the cambium and medullary rays, the latter from 1 to 3 cells wide; all the cells in this zone show a collenchymatous thickening of the walls and contain an amorphous substance similar to that found in cells of the outer bark; (5) a *cambium ring* of about one layer of meristematic cells; (6) a *xylem* composed of a lignified and a non-lignified portion. The *lignified portion*

consists of oval, circular or somewhat angular tracheæ with slit-like pores and reticulate markings (as seen in longitudinal view) occurring isolated or in groups of 2 or 3, angular wood-fibers with oblique simple pores, tracheids, and narrow lignified medullary rays, the latter 1- to 4-cells wide being rather indistinct and resembling the wood-fibers. The *non-lignified portion* (seen only in sections cut at certain levels) consists of wood parenchyma. Tissues of the central region of wood colored yellowish- or reddish-brown on the addition of a drop of potassium hydroxide T.S. Sections cut below root branches show a broad, short medullary ray.

**Powdered Drug.**—Pale brown to weak yellow with an odor resembling methyl salicylate, somewhat sternutatory; consisting of fragments of lignified simple-pitted, reticulate, and bordered pored tracheæ with oblique end walls, thick-walled, taper-ended wood fibers, with slit-like pores, short pointed tracheids with numerous bordered pores, fragments of sieve tissue parenchyma, the latter containing a pale yellow amorphous substance, and collenchymatic to lignified medullary-ray cells with simple pores.

**Constituents.**—The saponin glycosides *senegin* and *polygalic acid*, the former being of the nature of a saponin, the latter feebly acidic and sternutatory; methyl salicylate, pectin, resin, sugar, etc.

Methyl salicylate occurs in greatest quantities in the recently gathered drug as well as in the dried drug that has been carefully prepared and stored.

**Use.**—Expectorant in sub-acute and chronic bronchitis.

**Average Dose.**—1 Gm. (15 grains).

**Preparations.**—Senega Fluidextract, N.F., 1 cc. which enters into Senega Syrup, N.F., 4 cc.; Stoke's Expectorant (Mistura Pectoralis) (from Fld. Ext.), 4 cc.; and Compound Squill Syrup (Hive Syrup) (From Fld. Ext.), 2 cc.

### EUPHORBIACEÆ (SPURGE FAMILY)

Often herbaceous, more rarely shrubby, rather seldom arborescent plants. Stem, leaves and other parts in several genera traversed by latex canals that are either ramifying cells (*Euphorbia*) or laticiferous vessels (*Manihot*, *Hevea*, etc.) or rows of laticiferous sacs (*Micrandra*) and contain a white latex with acrid, often poisonous contents or alkaloid or hydrocarbon, at times, rubber contents. Leaves alternate, exstipulate to stipulate, simple to pinnate or palmate. Inflorescence cymose. Flowers usually, as in *Ricinus*, etc., pentamerous, diclinous; sepals five, green, aposepalous, becoming rudimentary or absent in *Anthostema* and *Euphorbia*. Petals none or five, more or less petaloid; stamens numerous to ten to five or one (*Euphorbia*); pistillate flowers rarely of twenty to ten apocarpous or loosely syncarpous carpels (Sandbox tree), commonly of three syncarpous carpels with distinct radiate styles; ovary as many-celled as carpels with two to one ovules in each cell. Fruit a tricocoid regma or capsule, rarely winged, indehiscent, nut-like. Seeds with oily endosperm. Flowers at times surrounded and subtended by more or less petaloid and expanded bracts and bracteoles.

## ELASTICA (RUBBER)

**Synonyms.**—Pará Rubber, South American Rubber, India Rubber, Caoutchouc; *Ger.* Federharz, Kautschuk; *Fr.* Caoutchouc.

**Botanical Origin.**—*Hevea brasiliensis* Muell. Arg. and other species of *Hevea*.

**Part Used.**—The prepared milk juice.

**Habitat.**—Northern South America.

**Plants.**—*Hevea brasiliensis*, the major source of Pará rubber, is a tree up to 125 ft. in height growing in dense forests along the Amazon river in Brazil. The leaves are alternate, trifoliate long petiolate with elliptic-lanceolate, straight veined, smooth leaflets, the latter attaining a length of about 2 ft.

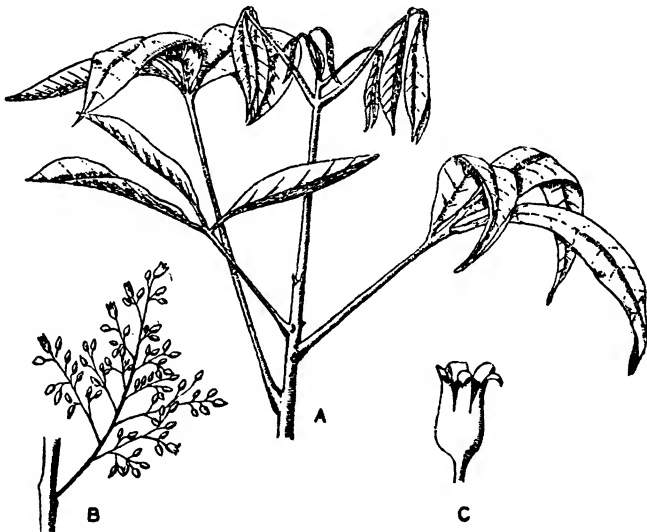


FIG. 252.—*Hevea brasiliensis*. A, young shoot; B, inflorescence, a panicle; C, flower. (From Gager, after R. H. Lock.)

The flowers are small, monoecious and apetalous and borne in pubescent panicles. The fruits are 3-parted capsules, each ripened carpel containing a large seed. *Hevea pauciflora* of British Guiana, *H. Benthamniana* of the northern Amazon region and *H. discolor* of the Rio Negro are lesser sources of rubber.

**Production and Commerce.**—Pará Rubber is collected from wild *Hevea brasiliensis* trees growing in Brazil (*wild rubber*) and from plants growing under cultivation in rubber plantations in Ceylon, Malaya, Burma, the Dutch East Indies, Africa and the Philippines (*plantation rubber*).

In Brazil, which yields Wild Rubber, the native rubber collectors are known as *seringueiros*. These men make vertical incisions in the bark of the tree to be tapped with a small iron axe (*machadinho*). Below each cut a tin cup is hung on the tree to catch the milk juice as it flows from the wound. When the cups are filled, their contents are poured into a tin pail which when filled is poured into a rubber covered cloth bag fastened to a wicker frame which the



worker carries on his back. The seringueiro builds a fire in a partly open hut which furnishes a dense smoke. The fruits of a palm (*Attalea excelsa*) are frequently burned for this purpose and emit dense clouds of oily smoke. He starts a ball of rubber by taking a long stick or wooden paddle and winding a film of air-coagulated latex around its end. The rod is placed horizontally across a support of two crossed poles and rotated over the smoke of the fire, its end given another coat of latex which is rotated above the smoke and heat of the fire until coagulated, successive coatings of latex being poured over the



FIG. 253.—*Castilla elastica*. Native method of tapping. A somewhat similar method is used with *Hevea*. (From Gager, after O. F. Cook. U. S. Dept. Agr. B. P. I. Bull. 49.)

matrix and coagulated by continued rotation of the stick over the fire until a mass of coagulated latex weighing up to about 65 kilos has been produced. This is removed from the stick, rolled and kneaded into a ball.

The old wooden paddle method is also employed in some parts of Brazil. The worker holds it over the smoke, then dips it into the latex, again thrusting it over the smoke of the fire and revolving it slowly, repeating the dipping and rolling maneuver until a bolacho or ham is formed, which is removed from the paddle, kneaded and rolled. Each bolacho consists of a number of layers of coagulated latex blackened on the surface by oxidation. The balls or hams of

rubber are sent down the Amazon by boat to Pará and Rio de Janeiro where they are boxed for export.

The preparation of *Plantation Rubber* in Southeastern Asia and adjacent islands is more scientific. There, either the herringbone or spiral systems are employed in tapping the trees. In the herringbone system, vertical channels are cut in the bark with lateral connecting channels about 1 foot apart at an angle of  $45^{\circ}$ , the latex being collected in cups attached to the tree at the base of the vertical channels. In the spiral system a series of spiral grooves are cut around the trunk. The latex is transferred from the cups to tanks or casks and coagulated by acetic acid. The coagulated latex is then washed and cut up

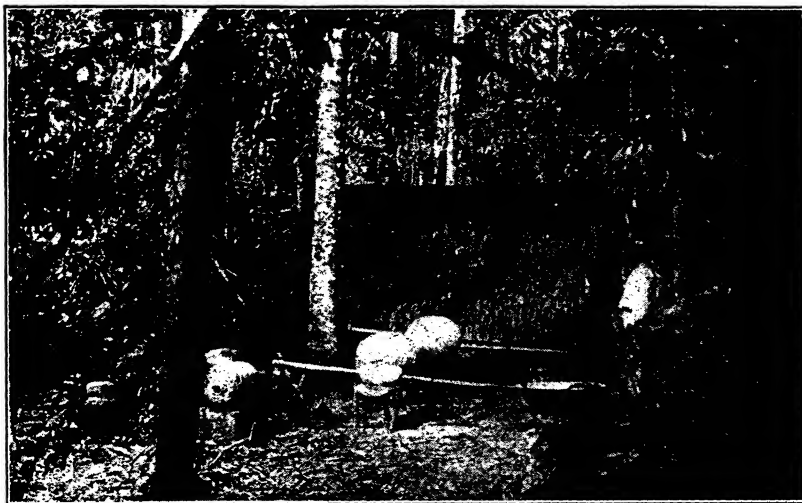


FIG. 254.—Pará rubber. "Biscuits" ready for shipment. They are formed by pouring latex on the pole or "paddle" as the latter is rotated over a fire. (From Gager, after R. H. Lock.)

into small pieces which are passed through the corrugated rollers of a machine, coming out as ribbons or "*crepe*" which are dried. Sometimes this rubber is coagulated in shallow vessels from which it is removed as a block or cake. This is known as "*biscuit rubber*." The plantation rubbers are lighter in color than the rubber made in Brazil. Crepe rubber occurs in crinkled sheets of an amber color.

*Vulcanized rubber* is made either by pounding soft rubber with 12 to 20 per cent. of powdered sulphur and heating at a temperature from  $135^{\circ}\text{C.}$  to  $160^{\circ}\text{C.}$  or by treating soft rubber with a solution of sulphur chloride in carbon disulphide. *Hard rubber* (*vulcanite*, *ebonite*) is rubber heated with about 30 per cent. of sulphur.

**Description.**—Pará rubber occurs in elastic, rounded, flask-shaped or flattened masses or in pieces of these; floating on water; externally brownish to brownish-black; internally mottled, with a paler tint, and exhibiting a laminated structure due to the superimposed layers of coagulated latex; odor character-

istically empyreumatic; nearly tasteless. It is soluble, except for a gelatinous substance, in carbon disulphide, chloroform, oil of turpentine, petroleum benzine and benzene, and melts when heated to 125°C.

**Constituents.**—From 40 to 60 per cent. of *caoutchouc*, which is a white hydrocarbon having the formula of  $(C_{10}H_{18})_n$ , a gelatinous substance, coloring matter, a small amount of resin, volatile oil, and mineral matter including sulphur, etc. *Caoutchouc* is contained in the latex of many plants, being especially abundant in many species of the *Euphorbiaceæ*, *Apocynaceæ* and *Moraceæ*.

**Uses.**—Pharmaceutically, rubber is employed as a basis for plasters. It is also used in the manufacture of numerous Druggist's sundries including catheters, syringes, hot water bottles, surgical implements, etc.

**Allied Products.**—Ceara rubber is obtained from *Manihot Glaziovii* (Fam. *Euphorbiaceæ*). Caucho rubber is derived from *Castilla ulei* and other species of *Castilla* (Fam. *Moraceæ*) growing in the Amazon basin. African Rubber is obtained from *Landolphia florida* and other species of *Landolphia*, woody vines, and from *Funtumia elastica*, a tree (Fam. *Apocynaceæ*). Borneo rubber is yielded by several species of *Urceola*. Guayule rubber, used in the construction of some automobile tires, is the product of *Parthenium argentatum* (Fam. *Compositæ*), a Mexican desert shrub. Rubber is also obtained from *Taraxacum kok-saghyz* Rod., (Fam. *Compositæ*), a dandelion native to the valleys of the Tien Shan mountains of Kazakhstan in U.S.S.R. Its roots yield up to 27.89 per cent of their weight of rubber.

#### AMYLUM MANIHOT (CASSAVA STARCH)

**Synonyms.**—Brazilian-, Bahia-, Rio-, or Pará-Arrowroot, Manioca Starch.

**Botanical Origin.**—*Manihot esculenta* Crantz (*Manihot utilissima* Pohl) and *Manihot dulcis* var. *Aipi* Pax.

**Part Used.**—The starch grains.

**Habitat.**—Brazil.

**Plants.**—Shrubs with fleshy rhizomes in a basal cluster, palmately-parted leaves with lanceolate lobes, paniculate flowers and 3-celled capsular fruits.

**Production.**—*Manihot esculenta* or **Bitter Cassava** is widely cultivated in Brazil and the West Indies as a food plant. Its fleshy roots contain an acrid, milky juice with prussic acid in their fresh state, but this poisonous constituent is eliminated in the process of washing out and drying the starch. *M. dulcis* var. *Aipi* or **Sweet Cassava** is grown in Florida and in other parts of subtropical and tropical America for cassava starch and tapioca flour.

The fleshy rhizomes of both of these plants are dug, washed, sliced and pulped. The pulp is placed on a strainer and the starch washed out by a powerful stream of water. It is received in suspension on inclined troughs and run into settling vats where it is stirred and washed. It is then dried.

**Description.**—A fine, white, mobile powder consisting of simple and 2- to 8-compound grains, the individual grains being rounded-truncate or kettledrum and flask-shaped, usually up to 30 $\mu$ , occasionally up to 35 $\mu$  in diameter, with a

central, circular or triangular hilum frequently with radiating clefts. Polarization cross distinct.

**Uses.**—As a nutrient, in the preparation of tapioca and as a sizing for cotton cloth.

**Tapioca** consists of partially gelatinized cassava starch. It is prepared by heating moist cassava starch on plates when the starch grains are caused to agglutinate in spherical masses (pearl tapioca), or the moistened starch may be raked on hot plates, the product being known as flake tapioca.

#### RICINUS (CASTOR OIL SEED)

**Synonyms.**—Castor Bean, Castor-oil Plant, Palma Christi; *Ger.* Ricinus-samen; *Fr.* Semences de ricin.



FIG. 255.—*Ricinus communis*, the Castor-oil plant. Note the peltate, palmately-lobed leaves.

**Botanical Origin.**—*Ricinus communis* Linné.

**Part Used.**—The dried ripe seed.

**Habitat.**—India. Widely naturalized and cultivated.

**Plant.**—The castor-oil plant is either found under cultivation or growing wild in most tropical and warm temperate countries. It varies from an annual, monoecious herb in temperate regions to a tree attaining the height of 40 feet

in the tropics. There are hundreds of forms of the plant which vary in size, color of stem and leaves, leaf markings, branching, size, color and markings of seeds, etc. The leaves are large, alternate, peltate, palmately 5-12 lobed, the lobes serrate or dentate. The inflorescence is a raceme of staminate and pistillate flowers, the pistillate flowers occurring above the staminate on the floral axis. The fruit is a 3-celled capsule covered generally with soft spines and dehiscent into 3 cocci, each containing an ovoid albuminous seed.

**Production and Commerce.**—Most of the commercial castor seed is produced in Brazil, Portuguese Africa, Haiti, Cuba, Nicaragua and Guatemala, Ecuador, Paraguay, Mexico and Oklahoma. The plant is propagated from seed and



FIG. 256.—Castor-oil seeds (*Ricinus communis*).

thrives best in fertilized sandy loam containing some lime and in warm regions having long growing seasons. When grown on a large scale, bee-hives are essential in order to insure well developed seed. The castor oil is obtained from the seed chiefly by the "cold press" method, castor oil cake or pomace being a by-product. During 1947, 8,024,106 pounds of castor oil were imported into this country from Brazil, Argentina, Mexico, Siam, British Malaya, Salvador, Guatemala, Nicaragua, Ecuador, Uruguay, and Paraguay.

**Description.**—Seed anatropous, albuminous, ovate-oblong, from 8 to 18 mm. in length and up to about 8 mm. in breadth, flattened on the ventral surface, the dorsal surface convex; at one end is a wart-like caruncle covering the micropyle from which a line-like raphe extends to the chalaza at the other end of the seed; testa smooth, glossy and brittle, grayish or gray-brown and marbled with

reddish-brown to black spots and lines; tegmen white, membranous, adhering to the large, yellowish-white, oily endosperm which surrounds a straight embryo; embryo extending lengthwise between the halves of endosperm and consisting of 2 papery cotyledons and a conical hypocotyl; nearly inodorous; taste oily and acrid. This seed should not be swallowed owing to its poisonous properties.

**Constituents.**—*Fixed oil* (Oleum Ricini U.S.P.) (45 to 50 per cent.) consisting of the glycerides of ricinoleic, isoricinoleic, dihydroxystearic acids, etc.; a crystalline alkaloid called *ricinine*; a toxin called *ricin*; lipase and other enzymes; gum, etc. Free ricinoleic acid is produced by hydrolysis of castor oil in the intestines. To it the purgative action of castor oil has been attributed.

**Uses.**—Castor-oil seeds are employed mainly for the preparation of castor oil which is extensively used as a purgative and lubricant. The cake representing the residue after extracting the oil is used as a fertilizer. It contains the poisonous toxin, *ricin*.

#### OLEUM RICINI U.S.P. (CASTOR OIL)

Castor Oil is the fixed oil obtained from the seeds of *Ricinus communis* L. It is a pale yellowish or almost colorless, transparent, viscid liquid. The official article is obtained by cold expression and has a faint, mild odor and a bland afterwards slightly acrid and usually nauseating taste. Its specific gravity is 0.945 to 0.965 at 25°C. It differs from most other fixed oils in being only partly soluble in petroleum benzine and in yielding a clear liquid with an equal volume of alcohol.

**Uses.**—Purgative and lubricant. Average dose, 15 cc. (4 fluidrachms).

**Preparations.**—Aromatic Castor Oil, N.F., 15 cc. (4 fl. dr.), Castor Oil Capsules, N.F., 15 cc. of castor oil.

#### STILLINGIA (STILLINGIA)

**Synonyms.**—Queensroot, Queen's Delight, Yaw Root, Silver Leaf; *Fr.* and *Ger.* Stillingie.

**Botanical Origin.**—*Stillingia sylvatica* Linné.

**Part Used.**—The dried root.

**Purity Rubric.**—It contains not more than 3 per cent. of foreign organic matter and yields not more than 2 per cent. of acid-insoluble ash and not less than 8 per cent. of alcohol-soluble extractive. "Stillingia which has been stored for more than 2 years must not be used." N.F. VII.

**Habitat.**—Southeastern United States, from Virginia to Florida.

**Plant.**—A perennial monoecious herb containing milk juice. From an underground, branched, slenderly fusiform root arises a smooth, erect stem which bears sessile, lanceolate, serrate leaves and yellow terminal spikes of flowers. The fruit is a rough, greenish-brown, 3-celled capsule, each cell containing a single seed.

**Description.**—Mostly in pieces, when entire, terete, unequally tapering, rarely branched, sometimes attaining a length of 40 cm., and from 0.5 to 3 cm. in diameter, externally brown to weak red upon abrasion of the cork, longi-

tudinally wrinkled; fracture very fibrous; internally the bark is weak red to light yellowish brown, thick, spongy, finely fibrous, with numerous resin cells and easily separable from the porous, radiate wood; odor distinct; taste bitter, acrid and pungent.

**Histology.**—*Transverse sections* of the thick, fusiform root show the following structure:

1. *Cork*, of an outer region of necrosed cells with thick walls and brownish contents and an inner region of thinner walled, lignified cells.
2. *Phellogen*, of meristematic cells.
3. *Secondary Cortex*, of starch-parenchyma, scattered tannin and oleoresin secretion cells, cells containing rosette aggregates of calcium oxalate and very narrow, branching laticiferous ducts.

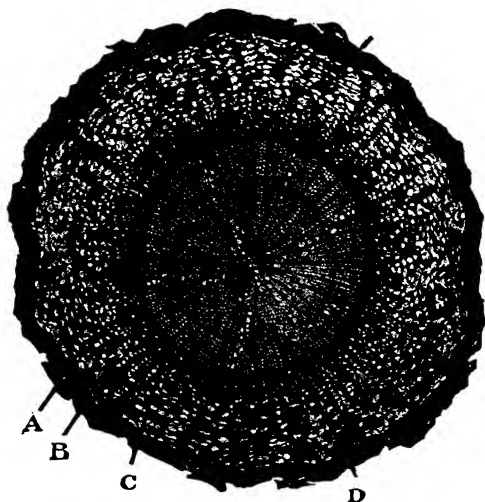


FIG. 257.—*Stillingia*—Cross-section of root. (17 diam.) (A) Cork; (B) parenchyma of phloem; (C) cambium at junction of xylem and phloem portions of a medullary ray; (D) xylem. (From Sayre.)

4. *Phloem*, a relatively broad zone composed of many radiating phloem strands separated by phloem portions of medullary rays, 1 to 2 cells wide. The phloem strands show phloem cells containing either starch, tannin or resin, scattered single or grouped, thick-walled, non-lignified or very slightly lignified bast fibers and strands of more or less collapsed sieve tubes.

5. *Cambium*, a distinct zone of meristematic cells forming a circular-wavy line.

6. *Xylem*, a broad central region, separated into many radiating wood-wedges by narrow medullary-rays 1 to 2 cells wide. Each wood wedge consists mostly of thin-walled, slightly lignified tracheids with occasional strands of tracheæ and occasional wood parenchyma cells.

*Longitudinal sections* show that the inner bark contains long, narrow bast fibers of irregular outline with strongly thickened, slightly lignified to non-lignified, tuberculated walls having longitudinal fissures and occasional cross

breaks and narrow lumina and that the xylem wood-wedges are composed largely of tracheids with very thin, lignified walls and transverse, slit-like pores and fewer tracheae with thicker walls and simple pores; the medullary rays crossing at right angles to the other elements. Both cortex and phloem contain extremely narrow, branching laticiferous ducts, best seen in stained tangential-longitudinal sections.

**Powdered Stillingia.**—Light brown, moderate yellowish brown to pinkish brown; starch grains numerous, mostly simple, ovate with the narrow end

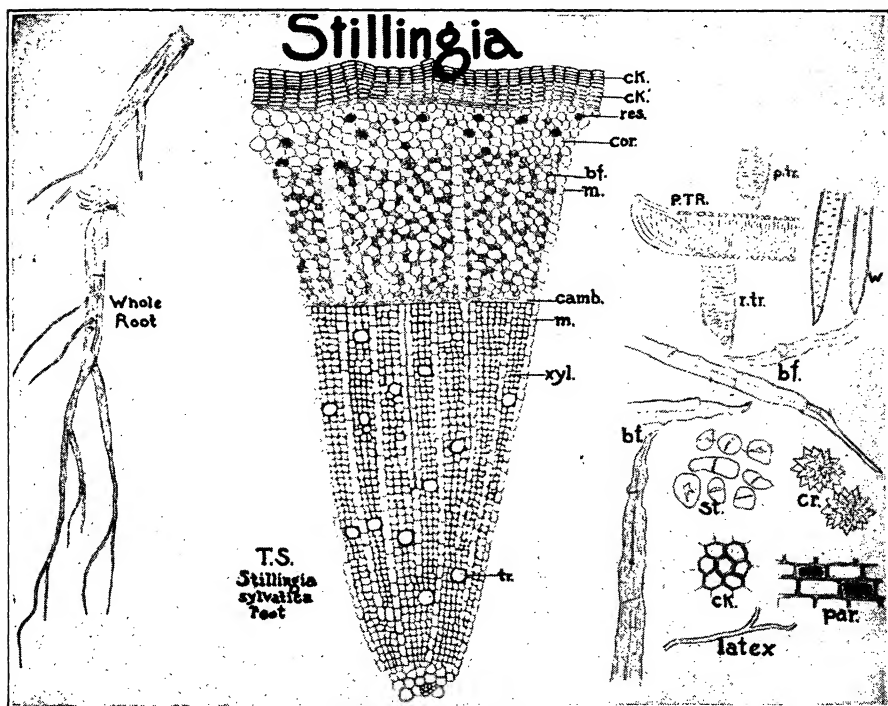


FIG. 258.—*Stillingia*. Entire roots to left. Transverse section of a representative portion of a root in center. Histological elements of powdered drug to right. *ck.*, cork; *ck.*, cork cambium; *cor.*, secondary cortex; *bf.*, bast fibers in phloem; *m.*, vascular ray; *camb.*, cambium; *xyl.*, xylem; *tr.*, trachea. Powdered Drug: *P.T.R.*, pitted trachea; *p.tr.*, pitted tracheid; *r.tr.*, reticulate tracheid; *bf.*, bast fibers; *st.*, starch grains; *ck.*, cork tissue; *latex*, laticiferous duct; *par.*, parenchyma; *w.*, wood fibers; *cr.*, rosette aggregates of calcium oxalate. [After Youngken and Vander Wyk in *Jour. A. Ph. A.* 28 (1939) 25.]

elongated, ellipsoidal or variable in shape, usually with a central cleft or stellate hilum and from 5 to 52 $\mu$  in diameter or length; numerous fragments of parenchyma, associated with secretion cells containing a reddish brown to orange, amorphous, resinous substance; occasional extremely narrow, branching, laticiferous ducts; numerous thin-walled, lignified tracheids with transverse, slit-like, simple pores associated with simple pitted or occasional reticulate tracheae; long, narrow, bast fibers with thick, irregular, non-lignified to slightly lignified and tuberculated walls, with longitudinal fissures and cross breaks, their lumina narrow and frequently interrupted; fragments of reddish orange to



yellowish brown cork cells; occasional rosette aggregates of calcium oxalate up to 70 $\mu$  in diameter. Reticulate tracheids have also been observed.

**Constituents.**—*Volatile oil* (3 to 4 per cent.) *acid fixed oil*, acid resin termed *sylvacrol*, *tannin* (10 to 12 per cent.), starch, calcium oxalate, etc. The older the drug, the darker is the color of its alcoholic extract and the lower its resin content.

**Uses.**—*Stillingia* is used empirically as an alterative and an antiscrofular, frequently in combination with other drugs.

**Average Dose.**—2 Gm. (30 grains).

**Preparation.**—Fluidextract, 2 cc.

**Adulterant.**—The chief causes of inferiority of *Stillingia* are moldy drug and old roots which are deficient in alcohol-soluble extractive.

#### EUPHORBIA PILULIFERA (EUPHORBIA PILULIFERA)

**Synonym.**—*Euphorbia*, Pill-bearing Spurge, Snake Weed, Cat's Hair.

**Botanical Origin.**—*Euphorbia pilulifera* Linné.

**Part Used.**—The dried plant.

**Purity Rubric.**—Not more than 5 per cent. of foreign organic matter; it yields not more than 4 per cent. of acid-insoluble ash.

**Habitat.**—India.

**Plant.**—An annual herb.

**Production and Commerce.**—The entire herb is collected in India when the plant is in flower or fruit and dried. The commercial supplies are shipped from India, those imported into the United States coming from London.

**Description.**—Roots usually present, small, branched, and orange to brown; stems slender, cylindrical, obliquely erect, dichotomously branched from near the base, branches recurved at apices; branches and stem only sparsely leafed toward the base, pale greenish-brown, rough and sparsely hairy below; stems coarsely pilose with yellow hairs which are rather dense on the upper parts but sparse on the lower; pubescence consisting of short, slightly curved, unicellular hairs, becoming almost hispid at the flowering tops; leaves 2 to 4 cm. long, opposite, oblong-lanceolate, acute, serrulate, dark green, when recent, but becoming dusky yellow to pale olive brown upon ageing, pubescent on both surfaces, especially on the prominent veins on the lower surface, becoming brittle on drying and usually much broken in the drug; flowers very small, numerous, in short peduncled axillary cymes; fruits, yellow 3-celled capsules about 2 mm. in diameter; seeds triangular ovoid, dark yellow, about 0.9 mm. in diameter. Odor aromatic and characteristic; taste faintly bitter, aromatic and acid.

**Constituents.**—*Alkaloid* (0.1 per cent.), *resins*, caoutchouc, *glucoside*, tannin, gum, etc.

**Use.**—*Euphorbia* is employed as a constituent of certain asthma preparations, including Hare's Elixir, N.F. VII. It is an antihistaminic.

**Average Dose.**—2 Gm. (30 grains).

**Preparations** (unof.).—Fluidextractum Euphorbiæ Piluliferæ, 2 cc.; Elixir Euphorbiæ Compositum (from Fld. Ext.) 4 cc.

#### EUPHORBIVM (EUPHORBIVM)

**Synonyms.**—*Ger.* Euphorbiumharz; *Fr.* Resine d'Euphorbe.

**Botanical Origin.**—*Euphorbia resinifera* Berg.

**Part Used.**—The dried resinous latex.

**Habitat.**—Morocco.

**Plant.**—A fleshy, cactus-like shrub with quadrangular branches less than two inches in thickness bearing along their angles scale-like leaves with prominent thorny stipules. The flowers are small, hermaphrodite, and borne on short peduncles in the leaf axils. The fruits are tricoccoid loosely attached ripened carpels.

**Production and Commerce.**—The Arabs collect Euphorbium from shrubs growing in the mountainous sections of Morocco by cutting incisions deep into the branches of the plants during the rainy season when the flow of latex is abundant. The white, sticky milk juice which is contained within long, branching, latex cells within the cortex and pith, exudes to the surface of the incision, some falling to the ground, but considerable solidifying in tears or lumps on the branches. It is collected by the Arabs in autumn, along with some debris, brought to the town of Morocco, then carried to Mogadore from whence it is exported.

**Description.**—Euphorbium occurs as dull light brown or yellow tears or as oblong or rounded masses of irregular outline about the size of a pea or larger, frequently enclosing thorns, flowers or fruits, often forked or perforated by small apertures produced by the spines of the branches around which the latex had solidified; very brittle; internally dull yellow to yellowish-brown; inodorous but sternutatory; taste very acid. It is partially soluble in alcohol, ether, petroleum ether and water and is almost completely soluble in glacial acetic acid.

**Identity Test.**—When a solution of Euphorbium is carefully poured over 20 cc. of sulfuric acid containing one drop of nitric acid, a blood red zone is developed at the junction of the two liquids.

**Constituents.**—*Euphorbone* (40 per cent.), which crystallizes from acetone in colorless, tasteless, acicular crystals, *euphorboresene*, a yellowish-brown, amorphous and tasteless substance (20 per cent.), an *acid substance* to which the physiological action of the drug is ascribed and which has only been isolated in impure form as an amorphous mass with a persistent acid taste, calcium malate (25 per cent.), vegetable debris, ash, about 5 per cent.

**Uses.**—Vesicant in veterinary medicine, drastic cathartic, and as a constituent of anti-foul paints for ship hulls.

#### CASCARILLA (CASCARILLA)

**Synonyms.**—Sweetwood Bark, Sweet Bark, Cascarillæ Cortex. *Fr.* Écorce éluthérienne; *Ger.* Kaskarillrinde.

**Botanical Origin.**—*Croton Eluteria* (Linné) Bennett.

**Part Used.**—The dried bark.

**Habitat.**—West Indies.

**Plant.**—A shrub or small tree.

**Commercial Source.**—Nassau, on island of New Providence, West Indies.

**Description.**—In quills or curved pieces from 0.5 to 2.5 mm. in thickness, externally gray, somewhat fissured; the corky layer easily detached, more or less coated with a white lichen; the uncoated surface dull-brown, inner surface smooth; fracture short, the fractured surface having a resinous and radially striate appearance. Odor characteristic, strong and musk-like when the bark is burned; taste warm, aromatic and very bitter.

**Constituents.**—*Volatile oil* (1.5 to 3 per cent.) containing *eugenol*; resin, the alkaloids betaine and cascarilline, a crystalline bitter principle (*cascarillin*), *vanillin*, tannin, starch, etc.

**Uses.**—Aromatic bitter. Also used in fumigating mixtures and in flavoring liquors and tobacco.

**Average Dose.**—2 Gm. (30 grains).

#### KAMALA N.F. (KAMALA)

**Synonyms.**—*Rottlera*, Kameela, *Glandulæ Rottleræ*, *Ger. Kamala*.

**Botanical Origin.**—*Mallotus philippinensis* Müller Argoviensis.

**Standard of Assay.**—It yields, when dried to constant weight at 100°C., not less than 66 per cent. of non-volatile, ether-soluble extractive.

**Acid-insoluble Ash.**—Not more than 6 per cent.

**Part Used.**—The hairs obtained from the capsules.

**Habitat.**—Southeastern Asia.

**Plant.**—A tree with alternate, ovate or oblong-ovate coriaceous, evergreen leaves, racemes of staminate and pistillate flowers, and glandular-hairy, 3-celled, septifragally dehiscent capsules, each locule containing a dark purplish brown seed.

**Production and Commerce.**—The plants abound in Indo-China, India and the Philippines where the ripe capsules are gathered by the natives who remove the hairs either by rolling the capsules in baskets and rubbing the surface of the fruits or by placing the fruits in a sack and beating until the hairs are removed. The hairs form a red powder, which is then passed through a sieve to remove sand, fragments of leaves, and other impurities. The drug is shipped from Indo-China and British India to the various markets of the world.

**Description.**—A finely granular, reddish brown or brick-red, inodorous and tasteless powder which when examined under the microscope shows numerous reddish brown to yellow glandular hairs with a short one-celled stalk (usually missing) and a nearly spheroidal, multicellular glandular head of 20 to 50 radiately elongated (ellipsoidal or spatulate) cells, more or less separated and immersed in the resinous secretion, each with an upraised or depressed cuticle. Amongst these glandular hairs will be found stellate aggregate hairs, composed of 5 to 20 thick-walled, non-glandular hairs which are generally curved or hooked

at their ends. Particles of sand of irregular, angular shape and fragments of epidermis of capsule may also be seen in the field.

**Constituents.**—An active taenifuge principle called *rottlerin*, a red resin, a yellow resin, wax, tannin, coloring matter, etc.

**Uses.**—Kamala is used as a taenifuge, as an anthelmintic to remove ascaris and threadworms, and as a dye-stuff.

**Average Dose.**—Humans, 7.5 Gm. (2 dr.); Fowls, 0.5 to 1.0 Gm. ( $7\frac{1}{2}$ –15 grains).

**Adulterants.**—Ferric oxide, sand, colored starch, etc.

**Substitute.**—Wars or wurus, consisting of the hairs of the fruits of *Flemingia macrophylla* (Willd.) O. Kuntze ex Prain (*F. congesta* Roxb.) (Fam. *Leguminosæ*). This material has a dull purple color and is distinguished microscopically by its somewhat ellipsoidal shaped glandular hairs and simple, 2-celled, non-glandular hairs, the basal cell of which is short, the terminal elongate and pointed.

#### ANACARDIACEÆ (SUMAC FAMILY)

Shrubs or trees often with resinous bark, and producing in stems and leaves secretion contents that are either acrid watery or acrid opalescent or white viscid, viscid acrid and poisonous. Leaves alternate, very rarely opposite, simple (*Cotinus Coggygia* Scop.), three-foliate (*Rhus toxicodendron*) or pinnate (*Rhus glabra*, *R. venenata*, etc.), exstipulate. Inflorescence frequently terminal and composed of racemes or cymes, often reduced to a simple raceme. Flowers small, mostly actinomorphic, clustered, green, greenish-white to greenish-yellow; sepals 5, rarely 6 or 4, green, small; petals 3 to 7, smaller than sepals, or absent; stamens equal in number to the petals and alternate, rarely fewer, frequently double in number, rarely indefinite, inserted hypogynously or upon an enlarged disc that surrounds or swells up between stamens and pistil; pistil monocarpellary, more rarely bicarpellary, very rarely, as in *Spondiæ*, of 10 to 5 carpels; ovary superior, 1-celled with single ovule. Fruit a drupe. Seeds exalbuminous with large embryo filling seed cavity.

#### RHUS GLABRA (RHUS GLABRA)

**Synonyms.**—Sumac Berries, Scarlet Sumac Fruit, Sleek; *Fr.* Sumac; *Ger.* Sumach.

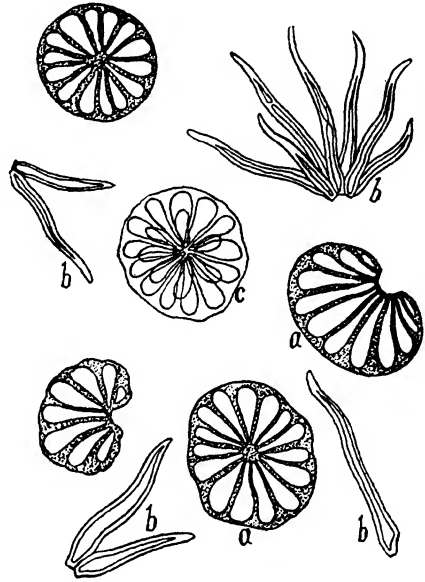


FIG. 259.—Kamala. (a) Deep reddish brown glandular trichomes; (b) aggregate simple trichomes; (c) gland decolorized with a weak solution of potassium hydrate. (Schneider.)

**Botanical Origin.**—*Rhus glabra* Linné.

**Part Used.**—The dried ripe fruit.

**Limit of Impurities.**—5 per cent. of stems or other foreign organic matter (U.S.P. X).

**Habitat.**—In old waste fields and along fences in Canada and United States.

**Plant.**—*Rhus glabra*, commonly known as Smooth Upland Sumac and Scarlet, White or Slick Sumac, varies from a shrub to rarely a tree, growing to the height of 1 to 6 m. The stems are smooth and somewhat glaucous. The leaves are alternate, exstipulate, imparipinnate with from 11 to 31 lanceolate or oblong-lanceolate leaflets. Each leaflet is dark green above, whitish



FIG. 260.—*Rhus glabra*. Branch with three imparipinnate leaves and a pyramidal cluster of drupes.

beneath, acuminate at the summit, rounded or oblique at the base and sharply serrate along the margin. Their color changes to red in autumn. The flowers are small, green and polygamous and arranged on erect terminal thyrses. The fruit is a crimson drupe containing a single exalbuminous seed. The bark and leaves of this plant are employed in the tanning and dyeing industries.

**Description.**—The drug occurs in the forms of entire drupes. Each is subglobular, somewhat compressed, 3.5 to 5.5 mm. in length and 2 to 4 mm. in diameter; externally dark-red, velvety with short hairs, summit with remnants of short style, base occasionally with a 5-cleft calyx and slender pedicel; epicarp and mesocarp, thin; endocarp smooth and shiny, reddish; seed dark brown, very hard, exalbuminous; odorless; taste sour and astringent.

**Powdered Drug.**—Brownish-red. Non-glandular hairs numerous, elliptical, spatulate or ovoid, uniseriate, up to 300 $\mu$  in length, containing a pink or red

cell-sap and often rod-shaped crystals; glandular hairs brownish or brownish-red, numerous, with a short, unicellular stalk and multicellular head; numerous fragments of endosperm; fragments of endocarp containing small stone cells with irregularly thickened walls and taking a red color with phloroglucin and

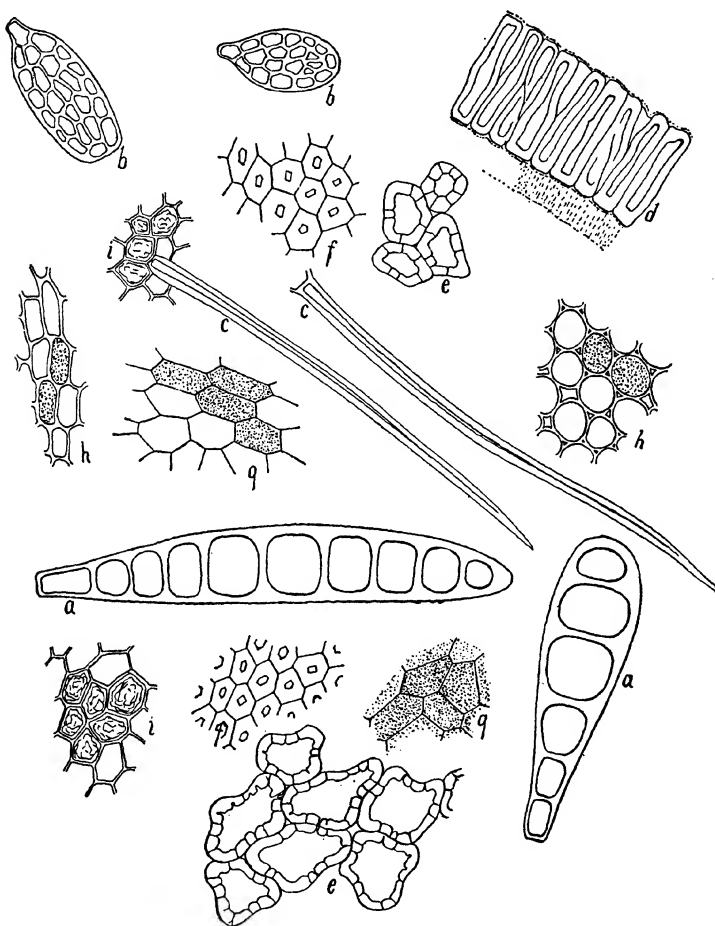


FIG. 261.—Powdered *Rhus Glabra*. (a) Deep red, uniseriate non-glandular trichomes; (b) brownish-red or brown glandular trichomes; (c) colorless unicellular trichomes; (d) outer layer of seed coat, lateral view; (e) thick-walled porous cells of testa; (f) colorless crystal-bearing layer of testa; (g) endosperm cells; (h) parenchyma of pericarp; (i) epidermal cells of pericarp. (After Schneider.)

hydrochloric acid; fragments of embryo with small angular cells containing aleurone and fixed oil; occasional fragments of reddish epicarp, with adhering mesocarp containing spiral tracheæ.

**Constituents.**—*Tannin*, gallic acid, *acid calcium and potassium malates*, fixed oil, coloring matter, etc.

**Uses.**—*Rhus Glabra* is employed as an astringent in gargles and as a refrigerant.

**Average Dose.**—1 Gm. (15 grains).



FIG. 262.—Poison Ivy (*Rhus toxicodendron* L.). A branch showing leaves and flower clusters on the new growth and clusters of berry-like fruits on the growth of the preceding year. (After W. C. Muenscher, *Cornell Extension Bull.* 191, 1934.)

**Substitute.**—The fruits of *Rhus typhina* L. or Staghorn Sumac, a small tree or shrub growing in lower Canada and the United States, are recognized by many to be superior to the official article on account of their higher total

acidity. These fruits may be distinguished from those of *R. glabra* by being densely covered with long, linear, crimson hairs.

#### TOXICODENDRON

*Toxicodendron radicans* (L.) Kuntze [*Rhus radicans* L., *R. Toxicodendron* of Amer. authors], commonly known as Poison Ivy and Three-leaved Ivy or Climbing Sumac, is a woody vine, climbing by aerial rootlets, or an erect bushy plant, having several races that differ in habit and shape of leaves. The leaves are petioled, 3-foliolate, each leaflet being short petioled, ovate or rhombic, entire or slightly sinuate or dentate, acuminate, inequilateral, rounded or narrowed at the base, glabrous or sparingly pubescent. The inflorescence is an axillary panicle of small green flowers. The fruit is a glabrous or slightly pubescent, grayish drupe. It is abundant throughout the greater part of the United States and very poisonous.

*Toxicodendron quercifolium* or Poison Oak (*Rhus Toxicodendron* L.) is a low branching shrub possessing densely pubescent young shoots, long petioled, 3-foliolate leaves with ovate or obovate dark green leaflets sparingly pubescent above and densely pubescent beneath, their margins irregularly lobed or sinuate-toothed. It is frequent in dry woodlands of the eastern U.S.

*Rhus Toxicodendron* was official in the sixth and seventh editions of the U.S.P. The fresh leaflets made into a fluidextract are occasionally employed internally in the treatment of nervous disorders and in dermatotherapy, particularly in the treatment of poisoning by the same plant.

There are probably no other plants in existence which cause as much human distress and suffering as *Toxicodendron radicans*, *T. quercifolium*, *T. vernix* and *T. diversilobum* all of which are responsible for so-called "Poison Ivy" dermatitis.

Hill, Mattacotti and Graham named the toxic, phenolic substance, causing the dermatitis, *urushiol*.

*Toxicodendron Vernix* (L.) Kuntze [*Rhus Vernix* L.; *R. venenata* DC.] is commonly known as poison sumac, swamp-sumac, poison elder and poison dogwood. The latter synonym must not be confused with the flowering dogwood, which is a member of the *Cornaceæ* family.

It is a shrub possessing a slender clustered stem, which sometimes takes a tree-like form, reaching to a considerable height. The stem is brittle, showing for the most part a pithy region internally. The leaves are 7-13 foliolate, with slender reddish-green petioles. The leaflets are obovate, oblong, dark green and glossy on the ventral surface, paler on the dorsal side, and without marginal teeth. The midrib and veins are prominent. The flowers are diœcious and are in narrow axillary panicles, yellowish green to white in color. The fruit is a smooth, white drupe, often remaining on the branches until spring. The leaf scars are prominent, alternate and of a somewhat crescent shape. The bark on young stems is mottled with conspicuous lenticels.

Unicellular hairs occur on the epidermis of the stems and leaves. Resin canals found in the bark and in the veins of the leaves of this species are filled with a dark reddish-brown oleoresinous substance known to contain the poison-



ous constituent *urushiol*. Oleoresinous material exuding from the injured plants and adhering to the hairs and hardening thereon may, when the hairs are detached by air-currents, account for persons becoming infected after passing

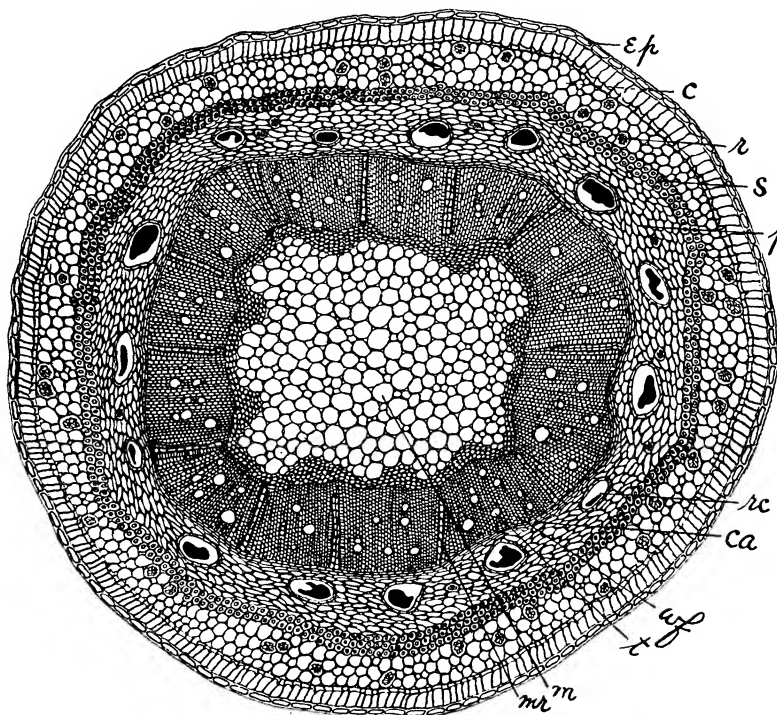


FIG. 263.—Transverse section of young stem of *Toxicodendron Vernix* (*Rhus venenata*). Epidermis (*ep*); cortex (*c*); rosette crystal of calcium oxalate (*r*); continuous ring of stereomatic tissue in pericycle (*s*); phloem (*p*); resin canals (*rc*); cambium (*ca*); wood fibers (*wf*); trachea of xylem (*t*); medullary-ray (*mr*); and pith (*m*).

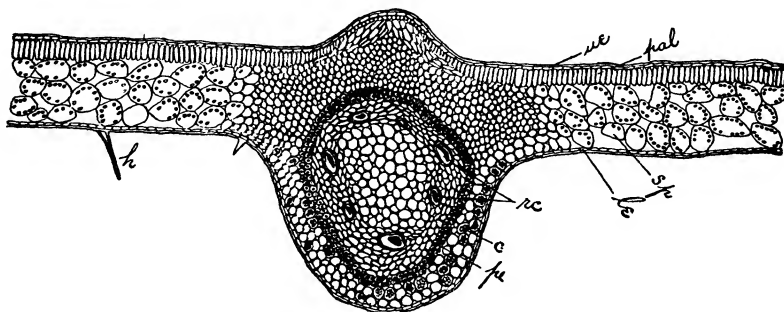


FIG. 264.—Transverse section through midrib and portion of lamina of *Toxicodendron Vernix*. Upper epidermis (*ue*); palisade parenchyma (*pal*); spongy parenchyma (*sp*); lower epidermis (*le*); resin canals (*rc*); rosette crystal of calcium oxalate (*c*); pericyclic fibers (*pe*); hair (*h*). Magnified.

by these plants, though not in direct contact with them. Contact with clothing, the fur of animals, or other objects soiled with the oleoresinous material from the poison ivy plants may also account for many cases of poison ivy dermatitis.

## POISON IVY AND POISON OAK ANTIGENS

A number of extracts or antigens prepared from the fresh leaves and twigs of poisonous *Toxicodendron* (*Rhus*) species are on the market which are intended for the prevention and treatment of the symptoms of the dermatitis produced through contact with these plants. They consist of solutions of urushiol or oily resin extractives. These are available in ampuls or vials and are intended for intramuscular injection. The following are among the available preparations: Ivyol Poison Ivy Extract (from *Rhus Toxicodendron*), Ivyol Poison Oak Extract (from *R. diversiloba*), Poison Ivy Extract (from *R. Toxicodendron*), Poison Oak Extract (from *R. diversiloba*), Poison Sumach Extract (from *Rhus venenata*, *Toxicodendron Vernix*); Rhus Tox. Antigen (from *R. Toxicodendron*), and Rhus Venenata Antigen (from *Toxicodendron Vernix*). *Rhus diversiloba*, more properly *Toxicodendron diversilobum*, is the Pacific Poison Oak.

## MASTIC N.F. (MASTICHE)

**Synonyms.**—*Pistacia* Galls, Lentisk, *Mastich*, Resina Mastiche; *Ger.* Mastix; *Fr.* Mastic.

**Botanical Origin.**—*Pistacia Lentiscus* Linné.

**Part Used.**—The concrete resinous exudation.

**Standard of Assay.**—Not more than 3 per cent. of ether-insoluble residue and not more than 20 per cent. of alcohol-insoluble residue.

**Limit of Impurities.**—1 per cent. of foreign organic matter, 0.25 per cent. of acid-insoluble ash.

**Habitat.**—Mediterranean Basin and islands.

**Plant.**—A dioecious shrub or small tree with smooth, brownish-gray bark and attaining a height of 3 to 4.5 m. Its leaves are alternate, paripinnate, with 6 to 10, oblong-ovate, entire leaflets. Its flowers are small, greenish and occur in axillary clusters. Its fruit is an orange-red obovate drupe.

**Production and Commerce.**—The mastic tree is cultivated on the island of Chios in the Grecian Archipelago but is found growing in Cyprus and other islands of this group. It is chiefly collected on the island of Chios from which the entire commercial supply is alone shipped to the markets of the world. The inner bark contains oleoresin reservoirs in which the drug is formed. Longitudinal incisions are made into this region of the stem at close intervals extending from the branches to the ground and the oleoresin induced to run. It collects as small tears on the outside of the wounds which, after hardening, are collected. Some tears are also collected from the branches, these having been formed through spontaneous exudation.

**Description.**—In sub-globular, lenticular ovoid or pyriform tears, about 3 mm in diameter and from 3 to 7 mm. in length, moderate yellow or greenish-yellow, transparent having a glassy luster, the surface occasionally dusty; brittle, becoming plastic when chewed; odor slight, balsamic; taste mildly terebinthinate. Not less than 97 per cent. of the drug is soluble in ether and not less than 80 per cent. is soluble in alcohol. Its acid number is not less than 50.

**Constituents.**—About 90 per cent. of resin consisting of *alpha resin* of *mastiche* (*masticic acid*) which is soluble in alcohol and beta-resin, insoluble in alcohol:  $\alpha$ - and  $\beta$ -masticonic acid,  $\alpha$ - and  $\beta$ -masticoresene; up to 2.5 per cent. of volatile oil consisting chiefly of *d*-pinene; bitter principle, etc.

**Uses.**—Mastic is used in solution as a filling for carious teeth and in the manufacture of paints and varnishes, also to modify the action of aloe in Lady Webster Dinner Pills.

**Average Dose** (unof.).—2 Gm. (30 grains).

**Preparation.**—Aloe and Mastic Pills, N.F. (Lady Webster Dinner Pills), 2 pills.

**Adulterants.**—Resins from allied species of *Pistacia*, notably *P. mutica* and *P. Khinjuk* (Bombay Mastic) and *P. Terebinthinus* (Chios Turpentine), Sandarac and Olibanum.

**Allied Plant.**—*Pistacia vera* L., a tree native to Syria and cultivated in Syria, Persia and Sicily yields Pistachio nuts or green almonds which are highly esteemed as a food. They contain, in their shelled condition, up to 54.9 per cent. of fixed oil, 22.8 per cent. of protein and 16.3 per cent. of carbohydrates.

#### SCHINOPSIS (SCHINOPSIS)

**Synonyms.**—Red Quebracho Wood, Quebracho Colorado, Lorentz Red Quebracho.

**Definition.**—The dried heartwood of *Schinopsis Lorentzii* (Grisebach) Engl. (*Quebrachia Lorentzii* Grisebach) and *S. Balansæ* Engl. (Fam. *Anacardiaceæ*).

**Plants.**—Trees native to Argentina and Paraguay with a dark brown bark and heavy, dark red heartwood rich in catechol-tannin.

**Commercial.**—Large amounts of red quebracho wood and extract are exported to the United States and other countries from Argentina, Paraguay and Uruguay to be used in the tanning of leather. In 1945, 176,646,916 lbs. of Quebracho extract were imported into this country from Argentina, 52,839,056 lbs. from Paraguay and 3,512,456 lbs. from Uruguay. The heartwood weighs about 75 lbs. per cubic foot. It is chipped and extracted by boiling in water, and made into a liquid and a solid extract, both in South America and in the U.S.A. The solid extract averages about 65 per cent of tannin.

**Constituents.**—From 20 to 28 per cent. of a catechol tannin called *quebracho-tannin*, coloring matter, etc. The quebracho-tannin occurs as a reddish-brown powder which is freely soluble in water and slightly soluble in alcohol. It precipitates gelatin and albumen from solution and its solution forms a greenish-black precipitate with ferric alum T.S.

**Uses.**—A purified extract of Quebracho has been used in the treatment of burns. The crude extracts are employed as rapid-acting tans for leathers.

#### ANACARDIUM

Anacardium or West Indian Cashew-nut consists of the dried fruit of *Anacardium occidentale* L., a tree with ovate leaves and panicles of red flowers, native to the West Indies and cultivated in tropical countries.

The fruit occurs as a fleshy, pear-shaped receptacle bearing at its summit a reniform, dark brown nut containing a reddish-brown, kidney-shaped seed. The mesocarp possesses elliptical reservoirs imbedded in parenchyma. Within these reservoirs is a yellow or reddish, oily, vesicant principle called *cardol*, which dissolves in sulfuric acid forming a red liquid. *Anacardic* acid and tannin also occur in the pericarp. The seed contains 40 to 45 per cent. of a *fixed oil*, also protein and starch. It is used as a food after being roasted and sometimes salted. The black juice of the nut containing cardol and anacardic acid has been employed as a discutient and also for printing linen or cotton cloth; the oil in the treatment of leprosy and as a vermifuge.

#### ANACARDIUM ORIENTALE

*Anacardium Orientale*, the Oriental Cashew-nut or Marking-nut, represents the fruit of *Semecarpus Anacardium* L., a tree with greenish-white flowers and black, drupaceous fruits indigenous to India and cultivated in southern Florida. The fruits contain *cardol*, *anacardic acid*, the alkaloid *chuchunine* and tannin; the seeds, a *fixed oil*. The fixed oil is used in India as an application to floors of houses, serving as a repellent to termites. The black juice of the fruit is used in printing cotton cloth.

#### CELASTRACEÆ (STAFF TREE FAMILY)

Shrubs (*Euonymus*), or shrubby climbers (*Celastrus*) or trees. Leaves alternate, rarely opposite, simple, entire or toothed; stipules small and caducous or absent. Inflorescence of axillary cymes or terminal racemes. Flowers perfect (*Euonymus*, *Pachistima*) or polygamodioecious (*Celastrus*), greenish (*Celastrus*), greenish or yellowish-white (*Euonymus Europæus*), greenish-purple (*Euonymus americanus*) to dark-purple (*Euonymus atropurpureus*); calyx 4- to 5-lobed; corolla of 4 to 5 petals, rarely absent; stamens 4 to 5, perigynous, inserted on a disk, which fills the base of the calyx and sometimes covers the ovary; ovary superior, 1- to 5-celled. Fruit a 2- to 5-celled capsule. Seeds albuminous with fleshy, succulent, reddish or orange colored aril (*Euonymus*, *Celastrus*) or white membranous aril (*Pachistima*).

#### EUONYMUS (EUONYMUS) H.P.

**Synonyms.**—Wahoo Bark, Burning Bush; *Ger.* Spillbaumrinde; *Fr.* Écorce de fusain.

**Botanical Origin.**—*Euonymus atropurpureus* Jacquin.

**Part Used.**—The fresh bark (H.P.). The dried bark of the root (N.F. VII).

**Purity Rubric.**—Not more than 5 per cent. of adherent wood and not more than 2 per cent. of other foreign organic matter; it yields not more than 4 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—Eastern and Central United States and lower Canada.

**Plant.**—A shrub growing to the height of 6 to 10 feet or, rarely, (frequently west of the Mississippi) a slender tree 20 to 25 feet high, with a trunk 6 or 7 in. in diameter and covered with ash-gray fluted bark. It is found growing in rich

soil generally along the edge of woods, from Ontario to northern Florida and west to Montana, Arkansas and Oklahoma. The branchlets (twigs) are obtusely four-angled and bear simple, opposite, elliptical to ovate, acuminate, serrulate and membranous leaves, 2 to 5 in. long and 1 to 2 in. broad. The dark purple flowers appear on seven to fifteen flowered cymes from May until the middle of June. The fruit is a three to four deeply lobed capsule from one-half to two-thirds in. in diameter, with light purple valves. The seeds are characterized by being covered with a thin scarlet aril.

**Description.**—It occurs in transversely curved pieces or in single quills of variable size and 1 to 4 mm. thick. Its outer surface is grayish to grayish-

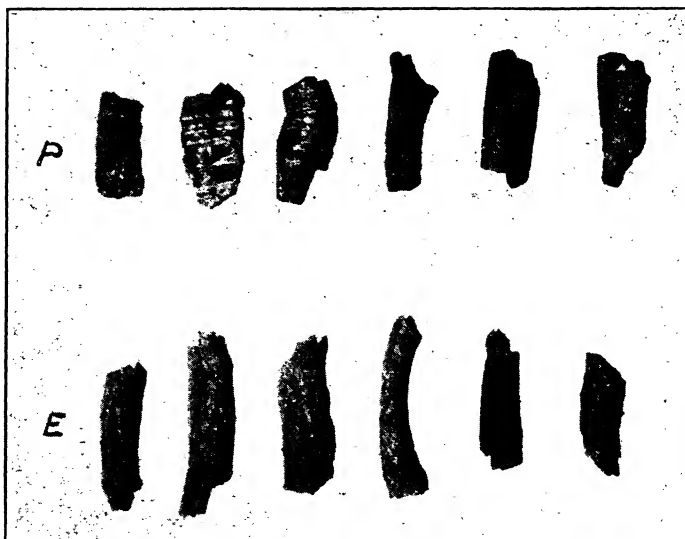


FIG. 265.—Wahoo (*Euonymus atropurpureus*) bark (E); Wafer ash (*Ptelea trifoliata*) bark (P).

brown, irregularly furrowed and ridged and showing a soft, scaly cork and occasional transverse lenticels. Its inner surface is light yellowish-brown to pale yellow, longitudinally striate and porous. Its fracture is short, exhibiting silky projecting, elastic threads of a caoutchouc-like substance. Its odor is characteristic and its taste, bitter and acrid.

**Histology.**—Under the microscope, passing from outer to inner surface, this bark presents the following peculiarities:

1. An irregular cork zone showing lenticels and many layers of tangentially elongated cork cells whose walls may be either suberized or slightly lignified.
2. A cork cambium of meristematic cells.
3. A narrow cortex of tangentially elongated cortical parenchyma, some of the cells of which contain more or less spheroidal starch grains while the others contain rosette aggregates of calcium oxalate.
4. A very broad phloem, occupying most of the width of the section and consisting of irregularly dome-shaped phloem masses, in cross section, traversed by wavy, secondary phloem rays, 1-cell in width. Primary phloem rays

separate the dome-shaped phloem masses one from the other. These are narrow in the inner phloem but broaden out into fan-shaped wedges farther out. Some of the phloem cells and phloem ray cells contain starch grains while others possess rosette aggregates of calcium oxalate. Secretory cells containing a reddish orange to yellowish orange, caoutchouc-like substance which dissolves in chloroform and carbon disulphide are found scattered about amidst other cells of the phloem region.

**Adulterant.**—The bark of *Ptelea trifoliata* Linné, commonly known as Wafer Ash, a small Rutaceous tree, attaining the height of from twenty to



FIG. 266.—Cross-section through root-bark of *Euonymus atropurpureus*. Note the two broad dome-shaped phloem patches, one on either side of a wedge-shaped, primary medullary-ray. Cork (*ck*); cork cambium (*k*); cortex (*c*); portion of medullary ray (*m*); phloem (*ph*).

twenty-five feet with a straight trunk six to twelve inches in diameter. It grows in rich moist soil from Lake Ontario to northern Florida and west to Minnesota and Colorado. Its branchlets bear alternate, rarely opposite, trifoliate leaves, each of which consists of a fairly stout petiole two and one-half to three inches long bearing upon its extremity three sub-sessile, ovate to oblong, serrate leaflets. The terminal leaflet is generally larger than the other two. The greenish-white flowers appear from March to June in terminal compound cymes and possess a rather disagreeable odor. The fruits are orbicular samaras two-thirds to three-fourths of an inch in diameter, the wing portion of each being membranous, reticulate and emarginate. They ripen in the southern latitude in early summer but not until late in autumn in the northern states and persist on the long slender pedicels until the following spring.

**Description of Wafer Ash Bark.**—This bark appears on the market in the form of irregular transversely curved pieces or in quills of variable size and three to four mm. thick. Its outer surface is light brown with prominent broad, irregular, transverse, grayish-white lenticels and transverse ridges. Its inner surface is brownish-yellow and smooth. Its fracture is short, the broken surfaces appearing waxy and pale yellow. The odor is faint and the taste bitter and acrid.

**Histology of Wafer Ash Bark.**—Under the microscope the following structural characteristics may be observed, passing from outer to inner surface:

1. Numerous layers of tangentially-elongated cork cells, the walls of which are nearly colorless and more or less lignified.
2. A cork cambium (phellogen) of delicate walled cells, rich in protoplasm and exhibiting cross walls. Many of the cells of this region possess solitary rhombohedral crystals of calcium oxalate.
3. Several layers of stone cells forming a continuous sclerenchyma sheath.
4. A broad cortex zone consisting of tangentially-elongated cortical parenchyma cells and intercellular-air-spaces. Some of the cortical parenchyma cells contain numerous spheroidal or ovate starch grains while others contain rosette aggregates of calcium oxalate. The starch grains are simple or two to four compound. Scattered about in the cortical and outer phloem regions will be seen sclerenchyma fibers either isolated or in small groups.
5. A broad phloem consisting of numerous phloem patches separated from each other by wavy phloem rays which are one to five cells wide as seen in tangential section. Secretion sacs containing oil are found scattered in both cortex and phloem. Some of the intercellular-air-spaces show rows of calcium oxalate crystals.

**Constituents of Euonymus.**—The crystalline alcohols, *euonymol*, *euonysterol*, *atropurol* and *homoeuonysterol*; *furan-β-carboxylic acid*, *citrullol*, tannin, calcium oxalate, starch, etc.

**Use.**—Cholagogue cathartic in torpid liver and constipation.

**Average Dose.**—0.5 Gm. ( $7\frac{1}{2}$  grains).

**Preparation.**—Fluidextract, 0.5 cc. (8 minims).

#### SAPINDACEÆ (SOAPBERRY FAMILY)

Trees, shrubs, undershrubs or climbers of tropical climes containing the glucoside saponin. Stem erect or climbing (*Paullinia*) often provided with tendrils. Leaves commonly alternate and compound. Flowers in racemes or panicles (*Paullinia*), perfect and usually polygamo-dioecious, (yellowish in *Paullinia Cupana*); sepals free or connate; petals 3 to 5; disk usually present; stamens hypogynous; ovary superior, 1- to 4- (often 3-) celled. Fruit a capsule (*P. Cupana*), samara, drupe or berry. Seeds exalbuminous, devoid of endosperm, often arillate.

#### GUARANA (GUARANA)

**Synonyms.**—Guarana Paste, Brazilian Cocoa, Guarana Bread; *Ger.* and *Fr.* Guarana.

**Botanical Origin.**—*Paullinia Cupana* Kunth.

**Part Used.**—Dried paste consisting chiefly of the crushed seed.

**Standard of Assay.**—Not less than 4 per cent. of anhydrous caffeine. N.F.

VII.

**Habitat.**—Brazil.

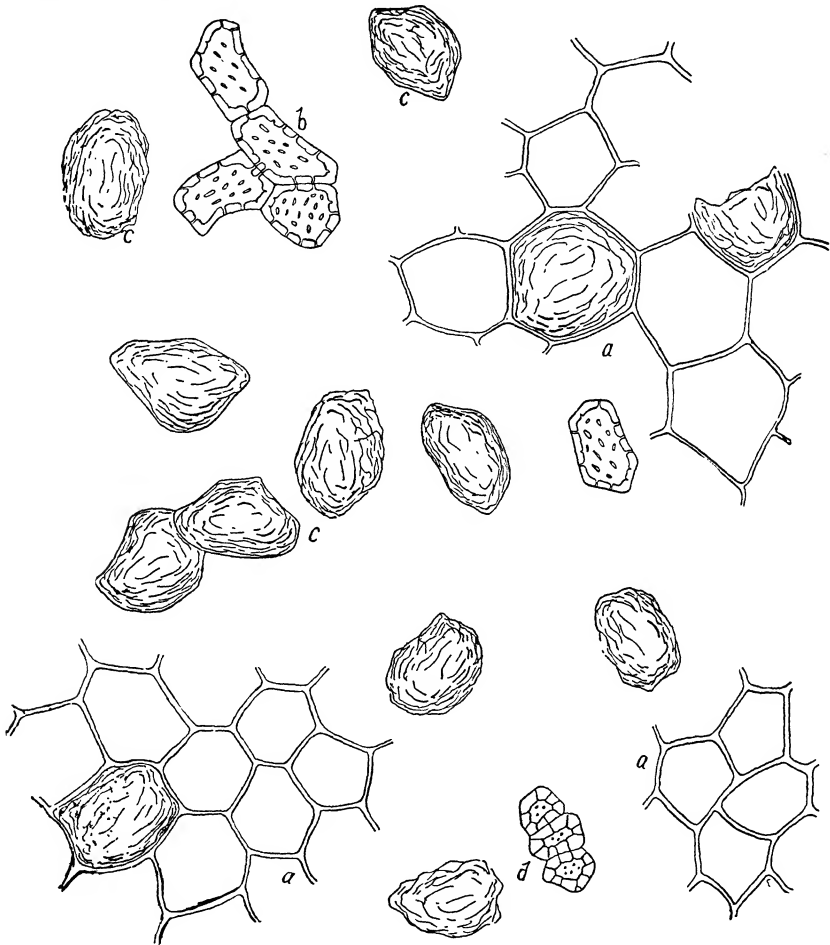


FIG. 267.—Powdered Guarana. (a) Parenchyma with pasty starch; (b) stone cells; (c) masses of pasty starch; (d) small stone cells. (After Schneider.)

**Plant.**—A climbing shrub. The leaves are alternate, imparipinnate, long petioled, with 5 oblong-ovate, roughly sinuate-serrate and acuminate leaflets. The inflorescences consist of axillary spicate panicles of yellow flowers. The fruit is an ovoid or pear-shaped capsule with a short beak and six-ribbed. The seeds are brownish black, about the size of a grape, and resemble small horse-chestnuts, each being invested with a flesh-colored aril.

**Production and Commerce.**—Guarana is prepared almost exclusively by the Guaranis, a tribe of South American Indians, from the seeds of plants which



are cultivated in the valleys of the Madeira, Maués and Ramos rivers, chiefly in the State of Amazonas, Brazil. Here the seeds are removed from the capsules, washed, roasted for about 6 hours, and their coats removed by placing them in bags and beating them with clubs. The kernels are then broken in a mortar, mixed with water and made into a doughy paste. Tapioca is sometimes added to increase plasticity. The paste is then moulded into cylindrical rolls and slowly dried by fire. The commercial supplies are obtained from Brazil.

**Description.**—Usually in cylindrical sticks, about 3 to 5 cm. in diameter, externally very dusky red to moderate brown; hard and heavy; fracture uneven, often fissured in the center; internally pale reddish brown, showing more or less coarse fragments of seeds and occasionally their dark brown integuments; odor slight; taste slightly astringent and bitter.

**Powdered Drug.**—Light brown, light yellowish brown or pinkish brown, consisting for the most part of irregular masses of parenchyma containing altered starch grains; unaltered starch grains occasional varying from spherical and polygonal to broadly ovoid and ellipsoidal shapes, up to  $25\mu$  in diameter; occasional fragments with narrow, elongated sclerenchymatous cells, the walls being thick, yellowish and non-lignified.

**Micro-chemic test:** Place on a slide a drop of hydrochloric acid, add about 0.001 Gm. of powdered Guarana, then add a drop of gold chloride T.S. and allow the mixture to stand for a few minutes; beginning at the edge of the mount, crystals of caffeine gold chloride separate in the form of orthorhombic plates and needles, the latter usually occurring in spheroidal aggregates and finally forming branching groups.

**Constituents.**—Up to 4.5 per cent. of *guaranine* (caffeine); guaranatin; tannin, catechin, volatile oil, fixed oil, saponin and starch.

**Use.**—Guarana is used as a stimulant in nervous headache and in the preparation of Guarana beverage.

**Average Dose.**—2 Gm. (30 grains).

**Preparations** (unof.).—Fluidextractum Guaranæ, 2 cc.; Elixir Guaranæ et Apii, 8 cc.

#### ACERACEÆ (MAPLE FAMILY)

Chiefly trees, occasionally shrubs, of temperate regions with watery sap. Leaves opposite, simple and palmately-lobed or cleft in most maples or pinnately-compound, as *Acer Negundo*, the Box Elder. Inflorescence a raceme, fascicle or corymb, condensing in some species to a capitulum of cymes. Flowers small, green, yellow or red, regular, polygamous or diœcious; sepals 5 or 4, green; petals none or 5, variously colored; stamens 4 to 10, usually 8, hypogynous or perigynous; nectar disc around stamens or between them and pistil; pistil bicarpellary with 2-celled ovary. Fruit a samara. Seeds green, exalbuminous, with coiled or folded embryo with elongated radicle and long thin cotyledons.

Histologically, the plant axis is characterized by the presence of sclerenchyma elements in the pericycle, narrow tracheæ with simple pores and wood fibers

with simple pores. Calcium oxalate occurs in either the form of monoclinic prisms or rosette aggregates.

The bark of *Acer spicatum* Lam. or Mountain Maple has been employed as a substitute for *Viburnum Opulus*. It contains astringent, but no nervine and uterine sedative principles.

The sap of the Sugar or Rock Maple (*Acer saccharum* Marsh.) is the main source of maple sugar. Other maples, particularly *A. saccharum* Marsh. var. *nigrum* (Mich. f.) Britton (Black Sugar Maple) and *A. saccharinum* L. (White or Silver Maple) yield smaller amounts of maple sugar. Most of the maple sugar is produced in Vermont, New York, Ohio, Michigan and New Hampshire. The trees are tapped early in the spring by driving a tubular spike into the wood of the trunk, several feet from the ground through which the sap flows into buckets. This is boiled to syrupy or sugar consistency.

#### RHAMNACEÆ (BUCKTHORN FAMILY)

Shrubs or low trees usually of branching or spreading habit. Branches either cylindric or long, green or hardened, checked back and spinescent, occasionally, especially flowering branches, developing tendrils for support. Leaves simple, usually alternate. Flowers hermaphrodite or more or less diclinous, pentamerous to tetramerous, greenish to greenish-yellow to yellowish-white; sepals five to four; petals five to four alternating with sepals; stamens five, opposite the petals, perigynous; pistil either free in center of a receptacular cup or more or less fused with it and so semi-inferior; ovary typically three-celled becoming rarely four-celled with two to one atropous ovules in each cavity. Fruit of three indehiscent cocci, each enclosing a single albuminous seed with straight embryo imbedded in albumen.

This family is characterized histologically as follows:

(1) The frequency of mucilage cells or lysigenous mucilage receptacles; (2) the presence in many plants of anthraquinone derivatives that give an orange to red color with alkaline solutions; (3) the frequency of glandular differentiation of the leaf teeth; (4) absence of glandular hairs; (5) non-glandular hairs either unicellular, uniseriate or stellate; (6) calcium oxalate in rosette aggregates and solitary crystals; (7) tracheæ with simple pores, or bordered pits (when in contact with medullary rays); (8) subepidermal development of cork; (9) mucilaginous modification of the epidermal cell walls of the leaf.

#### CASCARA SAGRADA U. S. P. (CASCARA SAGRADA)

**Synonyms.**—*Rhamnus Purshiana*, Sacred Bark, Chittem Bark, Bear Wood; *Ger.* Amerikanische Faulbaumrinde; *Fr.* Écorce sacrée.

**Botanical Origin.**—*Rhamnus Purshiana* De Candolle.

**Part Used.**—The dried bark.

**Purity Rubric.**—Cascara Sagrada contains not more than 4 per cent. of foreign organic matter and should be collected at least one year before being used for making medicinal preparations.

**Habitat.**—Southwestern Canada, Washington, Oregon, Montana, and northern California.

**Plant.**—A tree with reddish-brown bark and hairy twigs growing to the height of 4.5 to 10 m. The leaves are petiolate, elliptical, acuminate, serrulate, or sometimes entire, with 10 to 15 pairs of veins, dull green above and pubescent beneath. The inflorescence is an axillary umbellate cyme of small greenish flowers. The fruit is a turbinate, purplish black drupe about 8 mm. in length and composed of 3 indehiscent cocci.



FIG. 268.—Cascara Sagrada tree growing in Oregon. (Photograph by E. T. Stuhr.)

**Production and Commerce.**—The Cascara trees grow abundantly in northern California, Oregon, Washington and southwest British Columbia, from which districts the drug of commerce is obtained. The bark of the trunk and branches is usually gathered from April to September chiefly by Indians and ranchers who peel the bark off in long strips. In peeling, longitudinal incisions two to four inches apart are made along the trunk, generally before the tree is felled. The bark is then peeled off in strips to within one foot of the ground. The tree is next cut down and the bark removed from the branches in strips. Trees four inches or less in diameter are not employed, the bark on these being too thin. Foreign matter such as sand and moss is generally removed by scraping. The bark is then placed on racks or hung over galvanized wire, with sap side down-

ward, stretched tight and allowed to dry. It is subsequently broken into pieces and put into sacks holding from 50 to 100 pounds. The annual yield has been estimated as from 3 to 4 million pounds. The fresh bark contains a principle which acts as a gastro-intestinal irritant and emetic. It should be collected at least one year before being used medicinally.

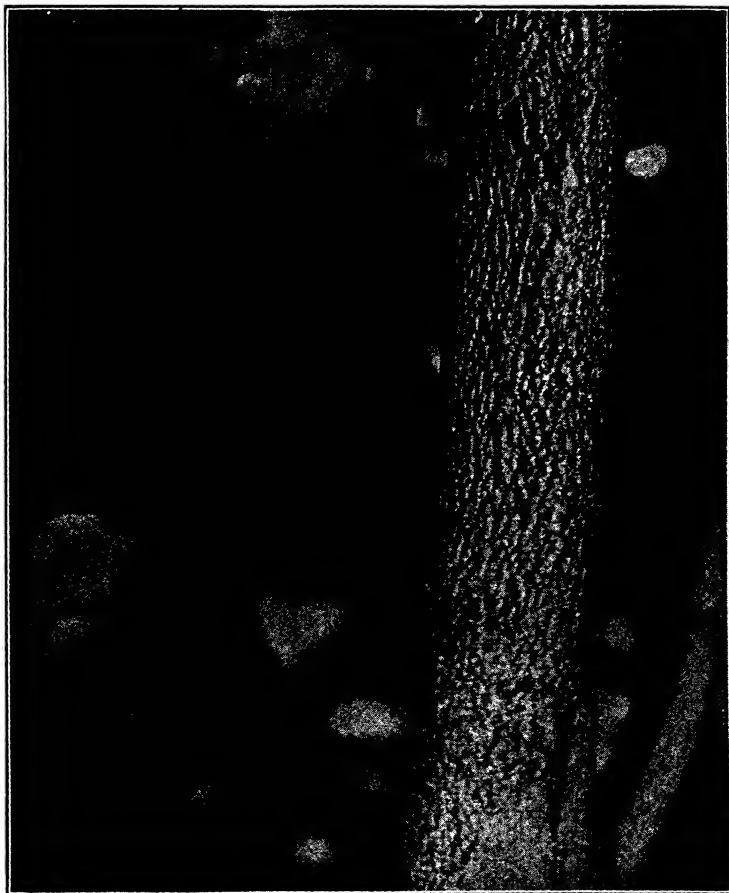


FIG. 269.—*Rhamnus Purshiana*. Portion of trunk and leaf and fruiting branches. (Courtesy of E. T. Stuhr.)

**Description.**—It occurs in flattened or transversely curved pieces or quills, of variable length and up to 5 mm. thick; outer surface dark-brown, purplish-brown or brownish-red, longitudinally ridged, frequently more or less covered with patches of grayish or whitish lichens bearing small blackish apothecia, sometimes with numerous lenticels and occasionally with moss; inner surface light-yellow to reddish-brown, or dark brown in old mature bark, longitudinally striate, becoming red when moistened with alkaline solutions; fracture short with projections of bast fibers in the inner bark; odor distinct; taste bitter and slightly acrid. It gives a red to reddish-brown color when treated with ammonia T.S.

**Histology.**—*In transverse section* passing from outer to inner surface, the following structural characteristics are evident: (See Fig. 270.)

1. **Cork**, or outer bark, yellowish-brown, purple or reddish-brown, composed of several layers of rectangular cork cells. The most external layers are dead

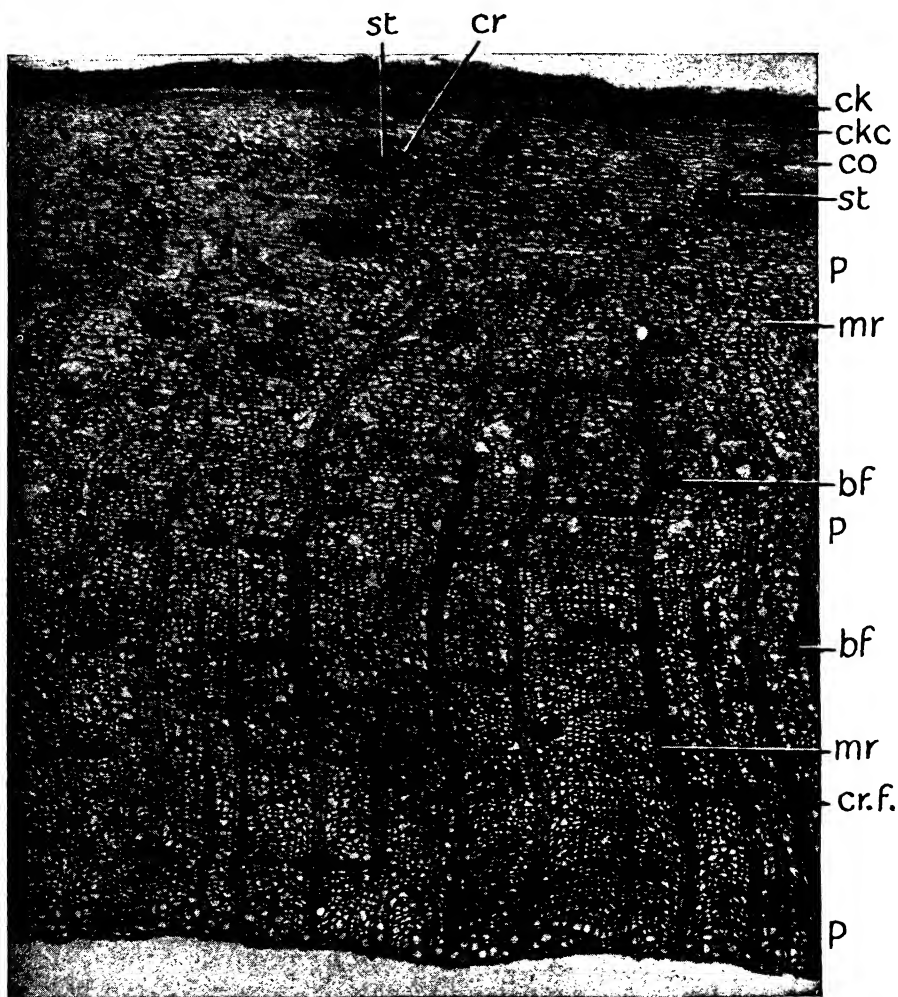


FIG. 270.—Transverse section of Cascara Sagrada stem bark,  $\times 50$ . *ck*, cork; *ckc*, cork cambium; *co*, cortex the outer region of which is collenchymatic; *st*, group of stone cells; *cr*, monoclinic prism of calcium oxalate; *P*, phloem; *mr*, medullary ray; *bf*, group of bast fibers; *cr.f.*, crystal fibers which closely surround groups of bast fibers and stone cells.

and appear black because they are filled with air. The inner layers of this region are living and have brownish, brownish-red or purplish contents.

2. **Cork cambium** (phellogen), a layer of delicate cells, with protoplasmic contents, in the process of division.

3. **Cortex**, or middle bark, consisting of two regions, viz.: an outer zone of two or three rows of brownish collenchyma cells, and an inner broader zone of

tangentially-elongated, cortical parenchyma cells with brown walls. Imbedded within this zone will be noted numerous yellow groups of stone cells, there being from 20 to 50 stone cells in a group.

4. **Phloem, or inner bark**, a very broad zone composed of irregular-shaped, elongated, phloem masses separated from each other by medullary rays which

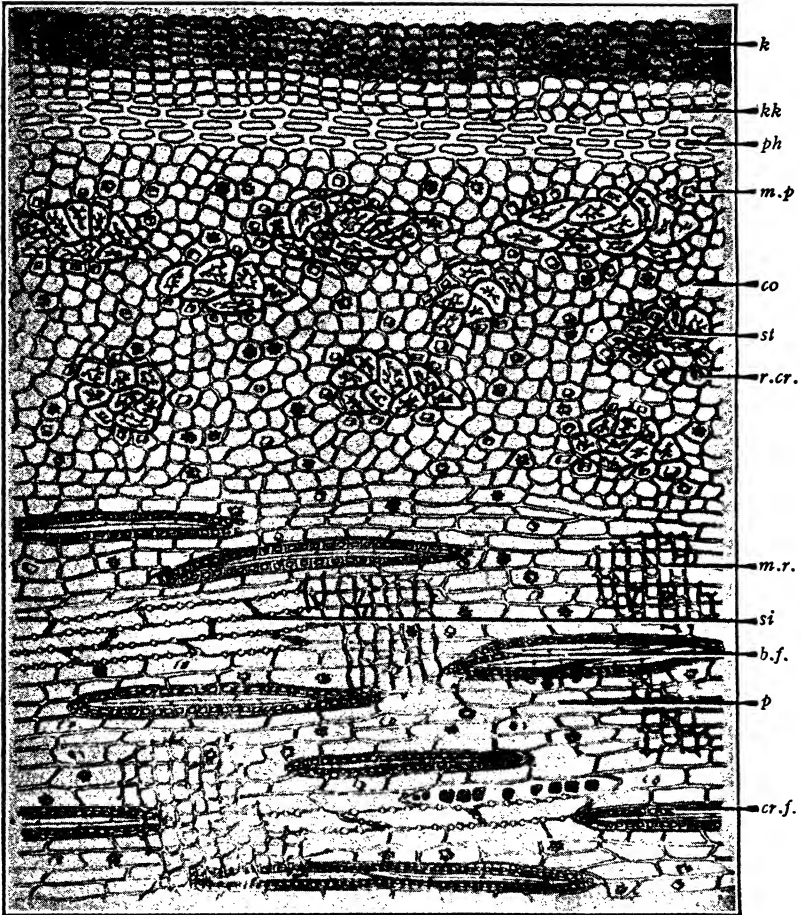


FIG. 271.—Radial-longitudinal section of Cascara Sagrada stem bark. *k*, cork; *kk*, phellogen; *ph*, phelloderm; *m.p.*, monoclinic prism and *r.cr.*, rosette aggregate of calcium oxalate; *co*, cortex; *st*, group of stone cells; *m.r.*, medullary ray; *si*, sieve tubes; *b.f.*, bast fibers; *p*, phloem; *cr.f.*, crystal fiber. (Courtesy of H. L. Reed.)

are frequently curved or diagonal and which converge in the outer phloem region. Each phloem mass consists of numerous sieve tubes and phloem cells, some of which latter contain spheroidal starch grains while others contain monoclinic prisms or rosette aggregates of calcium oxalate. Embedded within the phloem masses, in tier-like fashion, will be noted groups of bast fibers, each group of which is more or less surrounded by a row of crystal fibers, individual cells of which can only be made out in this kind of a section. Each of these

contains a monoclinic prism of calcium oxalate. The medullary rays possess brownish contents which take a red color with an alkaline solution.

*In radial longitudinal section*, a lengthwise view of the tissues will be seen. The medullary rays appear 15 to 25 cells in depth and crossing at right angles to the other elements. The crystal fibers here will be seen to be composed of vertical rows of superimposed thin-walled cells, each of which contains a monoclinic prism or twin prism of calcium oxalate. The bast fibers appear elongated and taper ended and are associated with crystal fibers. (See Fig. 271.)

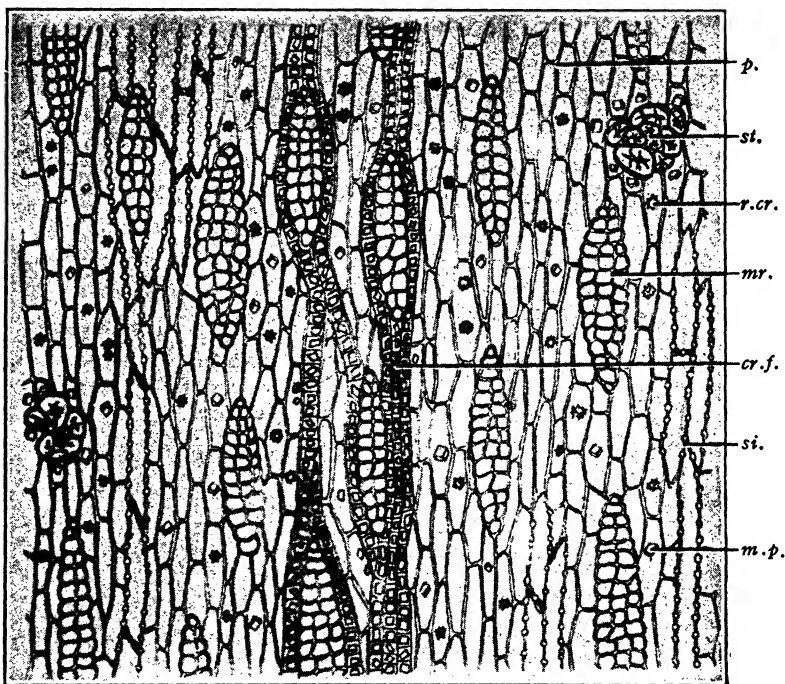


FIG. 272.—Tangential-longitudinal section of Cascara Sagrada stem bark through phloem region. *p.*, phloem parenchyma; *st.*, group of stone cells; *r.cr.*, rosette aggregate of calcium oxalate; *mr.*, medullary ray; *cr.f.*, crystal fibers; *si.*, sieve tubes; *m.p.*, monoclinic prism of calcium oxalate. (Courtesy of H. L. Reed.)

*In a tangential longitudinal section* which has been cut through the phloem, the exact range in width of the medullary rays may be ascertained. In this bark the medullary rays are spindle-shaped in tangential view and one to four cells in width. The sieve tubes possess callous plates on their transverse and longitudinal walls. (See Fig. 272.)

**Powdered Drug.**—Moderate yellowish-brown to dusky yellowish-orange. Numerous broken bundles of bast fibers adhering to which are crystal fibers containing monoclinic prisms of calcium oxalate; isolated monoclinic prisms or rosette aggregates of calcium oxalate, usually up to  $20\mu$  in diameter, occasionally up to  $45\mu$  in diameter; stone cells in masses or isolated, with thick, finely lamellated and porous walls; fragments of reddish-brown to yellow cork;

masses of parenchyma and medullary-ray tissue colored reddish-brown to orange upon addition of an alkaline solution; numerous spheroidal starch grains up to  $8\mu$  in diameter.

**Constituents.**—Anthraquinone derivatives including *emodin*, aloe-emodin, chrysophanic acid, and *isoemodin*; resins, rhaminol arachidate (a fat), an enzyme, tannin, glucose, starch, calcium oxalate, manganese, *methylhydroctoin*, etc.

**Use.**—Cascara sagrada is extensively used as a tonic laxative in habitual constipation.

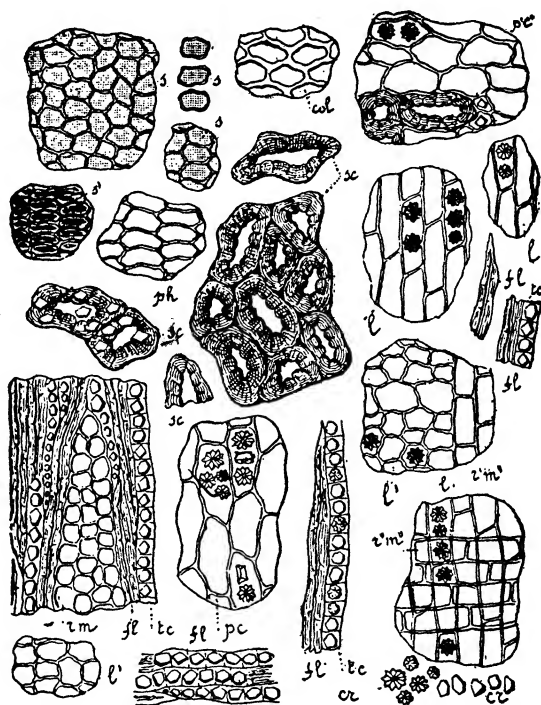


FIG. 273.—Powdered Cascara Sagrada Bark,  $\times 210$ . *col*, Collenchyma of the cortex. *cr*, Rosette aggregates and monoclinic prisms of calcium oxalate. *fl*, Bast fibers. *l, l'*, Phloem fragments as seen in longitudinal and transverse sections. *pc, p'c'*, Cortex fragments as viewed in longitudinal and transverse sections. *ph*, Phelloderm. *rm*, portion of medullary ray, tangential section. *r'm'*, medullary ray, transverse section. *r'm''*, the same, radial section. *s, s'*, Cork in surface view and section. *sc*, stone cells. *tc*, crystal fibers. (After Sayre, from Greenish and Collin.)

**Average Dose.**—1 Gm. (15 grains).

**Preparations.**—In U.S.P.—Cascara Sagrada Extract, 0.3 Gm. (5 grains); Cascara Sagrada Extract Tablets; Cascara Sagrada Fluidextract, 1 cc. (15 minims); Aromatic Cascara Sagrada Fluidextract, 2 cc. (30 minims). In N.F.—Cascara Sagrada Elixir, 4 cc.; Aloin, Belladonna, Cascara and Podophyllum Pills (from Ext.) (Hinkle's Pills), 1 pill; Aloin, Strychnine, Belladonna and Cascara Pills (from Ext.), 1 pill.

**Adulterants.**—(1) Bark of *Rhamnus californica* Eschsch., a shrub or tree attaining a height of 5 m. and bearing oblong to oblong-lanceolate leaves with



serrulate or entire margins and 8-12 pairs of veins, and red to purplish black fruits. The bark of this tree is invariably present in "Cascara Bark" collected in lower parts of California. It is best distinguished from the genuine article by its medullary rays which are broader, as observed in tangential sections, and by the inner cambium surface being distinctly crenate. (2) Douglas Fir bark. (3) Bark of a western alder. (4) Cherry bark.

#### FRANGULA (FRANGULA)

**Synonyms.**—Buckthorn Bark, Alder Buckthorn; *Fr.* Écorce de bourdaine; *Ger.* Faulbaumrinde.

**Botanical Origin.**—*Rhamnus Frangula* Linné.

**Part Used.**—The dried bark.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—Europe and Western Asia.

**Plant.**—A smooth, thornless, arborescent shrub growing to the height of 4.6 m. and frequently found growing in hedges. The leaves are broadly ovate in outline, obtuse at apex and entire or slightly sinuate along the margin. The flowers are hermaphrodite, pentamerous and arranged in axillary clusters of 2 or 3. The fruit is a dark purple juicy drupe with 3 nutlets.

**Production and Commerce.**—Frangula is collected in Russia, Germany and other European countries by stripping the bark from the stem and branches and drying it slowly. Like Cascara Sagrada, it contains in its fresh condition an emetic principle. The bark is kept for a year or longer before being marketed for medicinal use. During this time its glucoside frangulin is said to be developed and its emetic principle disappears. The commercial supplies of this bark are normally imported into the United States in bales or large bags from Hamburg and Trieste.

**Description.**—The drug occurs in quills or flattened pieces of variable length and breadth and from 0.5 to 1.5 mm. in thickness; outer surface varying from dusky red to light olive-brown, with numerous rounded or transversely elongated, lighter colored lenticels and occasional irregular patches of foliaceous lichens, some of which display small, blackish apothecia; inner surface smooth, dusky red to dusky yellowish-orange with scattered purplish blotches, finely longitudinally striate, becoming red when moistened with alkaline solutions; fracture short, slightly fibrous in the inner layer; odor distinct; taste slightly bitter.

**Histology.**—Transverse sections exhibit the following microscopical structures:

1. Cork, an undulate layer of numerous layers of purplish-brown, to reddish-brown, tabular cork cells, containing a purple to purple-crimson or brown coloring matter.

2. Cork cambium of meristematic cells, mostly collapsed.

3. Cortex of an outer zone of collenchyma and an inner zone of several layers of thin-walled cells, some of which contain a brownish amorphous sub-

stance, others minute starch grains, still others rosette aggregates of calcium oxalate up to  $25\mu$  in diameter.

4. Phloem, a broad region traversed by starch and active principle containing medullary-rays that tend to converge in groups. The phloem patches between the medullary-rays contain tangentially elongated groups of bast fibers having thick, strongly lignified, yellowish walls and narrow lumina. Each group of bast fibers is more or less surrounded by a layer of crystal fibers, the

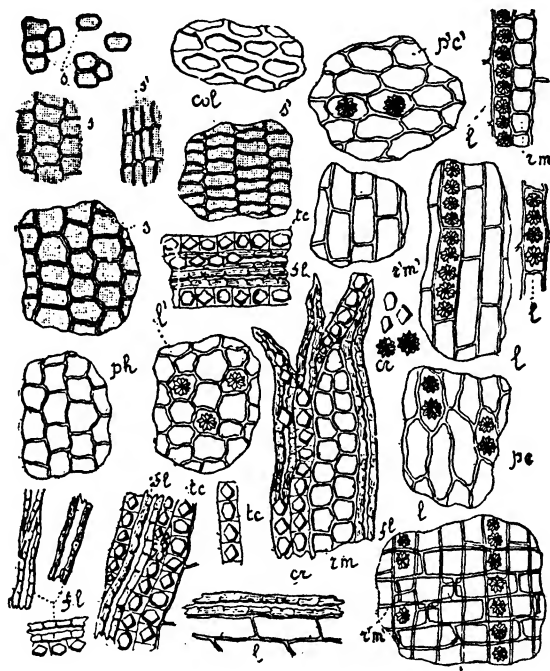


FIG. 274.—Powdered Frangula Bark (*Rhamnus Frangula*),  $\times 210$ . col, collenchyma of the cortex. cr, monoclinic prisms and rosette aggregates of calcium oxalate. fl, bast fibers with pitted walls. l, l', fragments of phloem in longitudinal and transverse section. pc, pc', cortical parenchyma, in longitudinal and transverse section. ph, phelloderm. rm, rm', medullary ray in tangential and radial-longitudinal section. s, s', cork in tangential and transverse section. tc, crystal fibers. (After Sayre, from Greenish and Collin.)

cells of which contain monoclinic prisms of calcium oxalate up to  $15\mu$  in diameter. The medullary-rays are 1 to 3 cells in width.

**Powdered Drug.**—Yellowish-orange to yellowish-brown and distinguished from that of Cascara Sagrada chiefly by its absence of stone cells. (See Fig. 274.)

**Constituents.**—The amorphous rhamno-glycoside called glucofrangulin, the decomposition product *frangulin* (a rhamnoside occurring in orange needles) which yields *frangula-emodin* and rhamnose on hydrolysis; pseudofrangulin (frangulic acid), a glucoside which yields *emodin* and glucose on hydrolysis, tannin, rhamnol, volatile oil, the sugars rhamnose and xylose, coloring matter, etc.

**Use.**—Tonic-laxative.

**Average Dose.**—1 Gm. (15 grains).

**Preparation.**—Fluidextract, 1 cc.

**Substitute.**—The bark of *Rhamnus carniolica* Kerner, distinguished from *Frangula* by being up to 3 mm. in thickness with reddish-brown cork, by its medullary-rays being 1 to 7 cells wide, by its cortex containing groups of stone cells and by its cork cells being devoid of purplish or crimson coloring matter.

#### RHAMNUS CATHARTICA (RHAMNUS CATHARTICA)

**Synonyms.**—Buckthorn Berries, *Baccæ Spinæ Cervinæ*, Hart's Thorn. *Ger.* Kreuzdornbeeren.

**Botanical Origin.**—*Rhamnus cathartica* Linné.

**Part Used.**—The dried ripe fruit. The ripe berries (H.P.).

**Purity Rubric.**—Not more than 5 per cent. of unripe fruit of the plant, not more than 2 per cent. of other foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—Northern Africa and Central Asia.

**Plant.**—A thorny shrub up to 12 ft. in height with thin, ovate to elliptic, crenate-serrate leaves and axillary clusters of small, 4-petaled flowers and greenish-black, globular, drupaceous fruits.

**Production and Commerce.**—The fruits are gathered when ripe in autumn and employed in the recent and dried condition. The commercial supplies of the drug come chiefly from Hungary.

**Description.**—Entire, globoid or ovoid, 4 to 8 mm. in diameter; externally purplish-black to very dusky red with a ring-like disk of 4-calyx teeth at the summit and with a short pedicel at the base, wrinkled in the dried state; internally exhibiting, when cut crosswise and examined with a hand lens, a greenish-yellow pericarp surrounding 4 locules 2 or 3 of which contain a triangular-convex seed-like nutlet; odor faint, unpleasant; taste sweetish, then nauseating and bitter. It colors the saliva purplish-red.

The unripe fruit which is to be rejected is dusky brown to weak olive green, with pedicel usually attached, very bitter and colors the saliva a greenish-yellow when masticated.

**Powdered Buckthorn-berries.**—Dusky brown. Numerous fragments of epidermis and parenchyma, some of the parenchyma cells containing an amorphous substance which is colored purplish-red or purplish-orange with chloral hydrate T.S., others with rosette aggregates of calcium oxalate, up to  $25\mu$  in diameter; fragments of sarcocarp of thin-walled parenchyma and secretion cells with oil contents, stone cells thick-walled from  $35$  to  $75\mu$  in diameter with a reddish-brown amorphous content or monoclinic prisms of calcium oxalate, the latter up to  $25\mu$  long; sclerenchyma fibers from endocarp long and thick-walled and associated with crystal fibers containing prisms of calcium oxalate; numerous fragments of endosperm the cells of which contain fixed oil and aleurone grains.

**Constituents.**—*Rhamno-emodin*, *rhamnocathartin* and *emodin-anthranol*; yellow coloring principles, pectin, sugar, a violet anthocyanin, gum, etc.

**Use.**—Purgative.

**Average Dose.**—1 Gm. (15 grains).

**Preparation.**—Fluidextractum (unof.), 1 cc. Syrup of Buckthorn (unof.), 4 cc.

**Adulterant.**—Cascara Sagrada fruits.

#### ZIZYPHUS (JUJUBE)

**Synonyms.**—Common Jujube, Chinese Jujube; *Ger.* Brustbeere; *Fr.* Jujube.

**Definition.**—The dried fruit of *Zizyphus Jujuba* Miller (*Z. sativa* Gaertn.) (Fam. *Rhamnaceæ*).

**Plant.**—A shrub to small tree native to Asia and cultivated in China, along the shores of the Mediterranean, in California and Alabama. It possesses alternate, ovate leaves, axillary cymes of yellow flowers and dark red, ovate-oblong fruits.

**Description.**—In ovate-oblong to sub-globular, drupes, up to 2.5 cm. in length; externally, black, more or less wrinkled with a thin, leathery epicarp; internally exhibiting a yellowish sarcocarp surrounding an oblong, furrowed and pointed putamen which encloses two locules, one of which may contain a perfect seed; odor characteristic; taste sweet and acidulous.

**Constituents.**—Zizyphic and tannic acids, sucrose, glucose, pectin, protein, fat, etc.

**Uses.**—The pulp of the fruit is employed in pastes, syrups and pastilles as a demulcent-sialagogue for the relief of bronchial affections; the fruit as a food.

#### STERCULIACEÆ (COLA FAMILY)

Rarely herbs, usually shrubs or tall, often heavy trees with soft wood and broad annual rings. The cambium, in developing bast, produces one, two, three, four or five alternating layers of hard and soft bast which, in some species of this as well as the *Tiliaceæ* family, form long finger-like processes pushing out into the cortex. Leaves alternate, sometimes simple and pinnately veined (*Theobroma*) or passing to palmately veined or palmately compound. Flowers hermaphrodite; sepals five, sometimes surrounded by bracteoles forming an epicalyx; petals usually five; stamens typically five, hypogynous, opposite petals, distinct or slightly fused in monadelphous fashion (*Melochia*, *Waltheria*) or, stamens subdivided above into few or numerous staminal leaflets, anthers two-celled; pistil many to ten- to five- or four-carpelled; carpels apocarpous or more usually partially or completely united. Fruit either follicles, or fused to form a capsule of ten or more, frequently five dehiscent carpels or, carpels splitting asunder into cocci or, becoming a woody capsular nut (*Theobroma*) or, rarely, the fruit may become succulent. Seeds globose or subglobose and often provided with wings, arils or similar appendages; embryo straight, large and surrounded by scanty albumen.

## SEMEN THEOBROMATIS (COCOA SEED)

**Synonyms.**—Cocoa Bean, Cacao Seed; *Fr.* Fèves du Mexique; *Ger.* Kakaobohnen.

**Botanical Origin.**—*Theobroma Cacao* Linné.

**Part Used.**—The prepared dried ripe seed.

**Habitat.**—South America, Central America, West Indies, and Mexico.

**Plant.**—A small tree growing to the height of 9 to 12 m. and bearing pink flowers which spring directly from its trunk and thicker branches. The fruit is a large, red, woody, melon-like, capsular nut containing about 50 to 70 seeds embedded in a mucilaginous pulp.

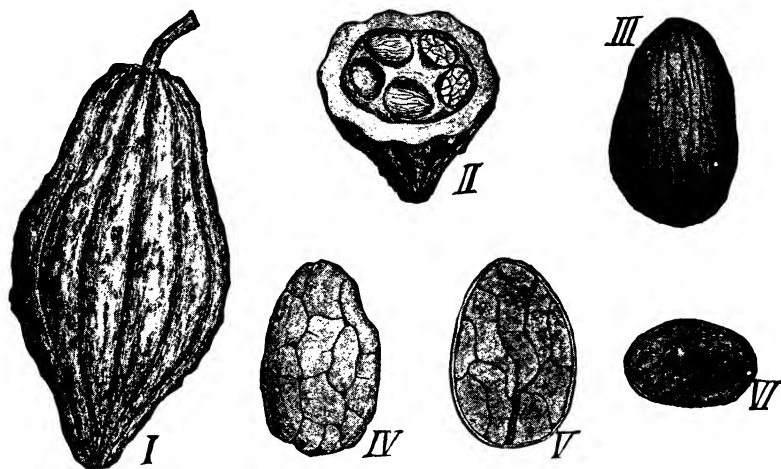


FIG. 275.—Cocoa. I, entire fruit; II, fruit in cross section,  $\times \frac{1}{4}$ ; III, seed; IV, seed deprived of spermoderm; V, seed in longitudinal section, showing radicle and peculiarly folded cotyledons; VI, seed in cross section, nat. size. (After Winton and Winton, "Structure and Composition of Foods," J. Wiley & Sons, Inc.)

**Production and Commerce.**—The fruits are split open with a long knife by the natives who remove the seeds and place them on trays or banana leaves, where they are allowed to undergo a fermentation (sweating process) induced by their own enzymes and by wild yeast of the air for from two to nine days, whereby certain bitter and acrid principles are destroyed. They are then spread out on concrete drying grounds and sun-dried, graded, and stored in bags. The commercial supplies come largely from Venezuela, Guiana, Brazil, Ecuador, Trinidad, Panama, Canal Zone, New Zealand, West Indies and the Gold Coast and Nigeria of West Africa. The Gold Coast produces about 35 per cent of the world's exports, South America and the Caribbean area, 32 per cent, all of Africa including the Gold Coast, 66.6 per cent.

**Cacao of commerce** represents the roasted kernels of the ripe seeds. After roasting Cocoa seed, the shell, representing the inner layers of the pericarp, spermoderm and perisperm, is readily removed. This is marketed as *cocoa shells*. The roasted embryo is then broken up and constitutes *cocoa nibs* or *cracked cocoa*.

**Chocolate**, also known as plain chocolate, bitter chocolate, chocolate liquor or chocolate coatings, is a solid or plastic mass prepared by grinding cocoa nibs without the removal of fat or other constituents.

**Sweet Chocolate** or sweet chocolate coatings represents chocolate mixed with sucrose and frequently with cocoa butter, spices and flavoring materials. **Milk Chocolate** is prepared by mixing powdered milk with sweet chocolate.

**Description**.—Seed with adherent inner layers of pericarp ellipsoidal or oblong-ovate, somewhat flattened, obtuse, 15 to 25 mm. in length; externally reddish-brown to dark brown, with hilum at broader end, connected with chalazas at the narrower end by a raphe which runs along one of the narrower sides; the thin brittle shell separable from the embryo; embryo, oily, reddish-brown to chocolate-brown and consisting of 2 fleshy, peculiarly folded cotyledons and a short hypocotyl, the latter at the hilum end; odor agreeable, characteristic; taste oily, aromatic and bitter.

**Histology**.—1. **Mesocarp** of collapsed parenchyma cells, sometimes with adherent yeast cells as the result of the curing of the “bean.”

2. **Endocarp**, a layer of elongated inner epidermal cells which in surface sections of the cacao bean shell are seen to cross the epidermal layer of the spermoderm diagonally, hence called *cross cells*.

3. **Spermoderm**, consisting of an outer layer of tangentially elongated epidermal cells, a zone of mucilage cells of larger size some of which show partition walls and which in defatted sections have contents of mucilage stained purplish to purplish red with ruthenium red and lead acetate solution, a region of spongy parenchyma through which course fibrovascular bundles, a layer of stone cells alternating in series with thinner walled cells. The stone cells possess thick radial and inner walls and are stained pink with phloroglucin-HCl reagent.

4. A zone of more or less **collapsed parenchyma** believed to represent perisperm.

5. **Endosperm**, a narrow zone of thin-walled cells which broadens in places and penetrates between the folds of the cotyledons. Fat crystals may be found in some of the cells penetrating into the folds.

6. **Embryo** consisting of two folded fleshy cotyledons, a hypocotyl terminating in the radicle, and plumule. The cotyledons and hypocotyl both exhibit Mitscherlichian bodies extending from their epidermis.

The cotyledons present for examination an *epidermis* and a broad *mesophyll* consisting of reserve parenchyma. The epidermis shows scattered outgrowths of peculiar multicellular hairs called *Mitscherlichian bodies* whose cells contain tiny brown bodies. The reserve parenchyma consists of isodiametric and elongated cells, most of which contain fat, aleurone grains and starch, the remainder known as pigment cells are scattered among the others. Upon clearing sections with ether, the starch grains and aleurone become clearly visible. The starch grains are single, spheroidal and 2- to 3-compound, the individual grains usually up to 12, occasionally up to 15 $\mu$  in diameter. The aleurone grains which are colored yellow by dilute Lugol's solution are up to 12 $\mu$  in diameter. The pigment cells contain a brown, brownish purple or reddish-brown, amorphous substance which is colored bluish-black to red with ferric chloride T.S.

**Constituents.**—The alkaloid *theobromine*, about 50 per cent. of *fixed oil*, 15 per cent. of starch, 15 per cent. of proteins, cacao-red and small amounts of

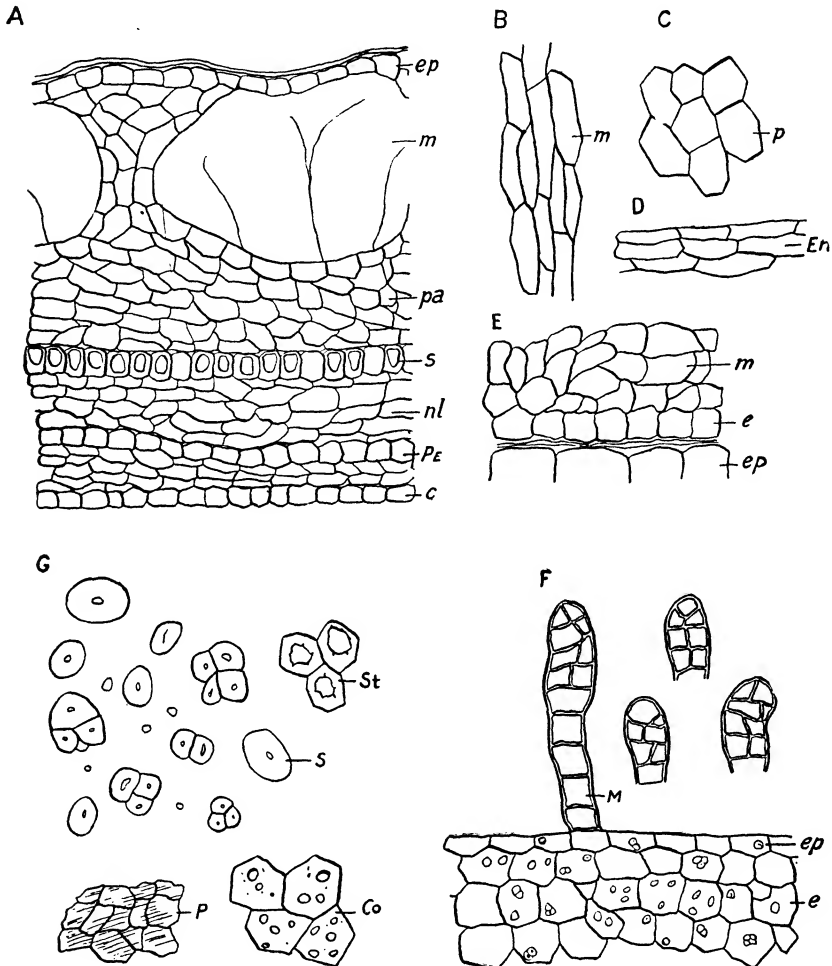


FIG. 276.—Chocolate (*Theobroma Cacao*) seed. A, Transverse section through outer region of seed. Epidermis of spermoderm (*ep*); mucilage cell (*m*); spongy parenchyma (*pa*); stone cell layer (*s*); nutritive layer (*nl*); perisperm (*Pe*); parenchyma (*c*). B, Surface view of mesocarp parenchyma. C, Epidermis of spermoderm in surface view. D, Surface view of endocarp. E, Cross-section through outer part of bean. Mesocarp (*m*); endocarp (*e*); outer epidermis of spermoderm (*ep*). F, cross-section through outer portion of cotyledon. Mit-scherlichian body (hair); epidermis of cotyledon (*ep*); starch and oil parenchyma (*e*). G, Powdered Cocoa. Stone cells (*st*); cells of cotyledon (*co*); starch (*s*); pigment cells (*p*).

*caffeine* and tannin. Theobromine and Sodium Salicylate, N.F. is employed as a diuretic, and vasodilator in cardiac diseases. 1 Gm. Theobromine and Sodium Acetate U.S.P. is used as a diuretic in dropsical conditions. Average dose, 0.5 Gm. Product—Theobromine and S. A. Capsules,  $7\frac{1}{2}$  grains. Theocalcin, N.N.R., consisting of calcium theobromine and calcium salicylate, is a diuretic, arterial dilator and myocardial stimulant.

## THEOBROMA OIL U.S.P. (OLEUM THEOBROMATIS)

**Synonyms.**—*Cacao Butter*, *Cocoa Butter*, Butter of Cacao; *Fr.* Oleum Concretum Semine Theobromæ Cacao, Beurre de Cacao; *Ger.* Kakaobutter.

**Botanical Origin.**—*Theobroma Cacao* Linné.

**Part Used.**—The fat obtained from the roasted seed.

**Description.**—Cacao butter is a yellowish-white solid, having an agreeable odor and a bland, chocolate-like taste. It is brittle at temperatures below 25°C. and melts between 30° and 35°C. It is freely soluble in ether, chloroform and benzene, soluble in boiling dehydrated alcohol and slightly soluble in 95 per cent. alcohol. Its saponification value is not less than 188 nor more than 195. Its iodine value is not less than 35 nor more than 40.

**Preparation.**—The seeds of the Chocolate plant are roasted and the seed coats or cocoa shells separated by winnowing. The oil is then expressed by subjecting the kernels to hydraulic pressure between hot iron plates and run into moulds, where it congeals.

**Adulterants.**—Wax, stearin and tallow have been occasionally found in Cacao butter. Either of these may be detected by the following test: Dissolve 1 Gm. of the suspected substance in 3 cc. of ether in a test tube at a temperature of 17°C. (63°F.), plunge the tube into a mixture of ice and water. If either of these substances be present, the liquid will become turbid or deposit white flakes in less than 3 minutes and will not clarify at 15°C.

**Constituents.**—The glycerides of arachic, oleic, palmitic and stearic acids.

**Uses.**—Cacao butter is used in the making of suppositories, as an excipient for certain pills, and as an emollient.

## CACAO N.F. (CACAO)

**Synonyms.**—*Cocoa*, Powdered Cocoa.

**Botanical Origin.**—*Theobroma Cacao* Linné.

**Part Used.**—A powder prepared from the roasted, cured kernels of the ripe seed.

**Standard of Assay.**—It yields not more than 22 per cent. of non-volatile ether-soluble extractive.

**Limit of Impurities.**—The ether-insoluble residue, dried to constant weight, yields not more than 7 per cent. of crude fiber, not more than 8 per cent. of total ash, and not more than 0.4 per cent of acid-insoluble ash.

**Description.**—A weak reddish-brown to moderate brown powder, devoid of sweetness, and having a chocolate-like odor and taste. The diagnostic histological elements are: numerous small, simple, spherical or 2- to 3-compound starch grains up to 15 $\mu$  in diameter, some of which have become altered during the curing and roasting processes and appear swollen and resembling in size and outline the starch grains of wheat and corn; needle and prismatic shaped crystals of fat, numerous aleurone grains, numerous fragments of parenchyma of cotyledons with thin-walled cells, some containing brownish, reddish-brown, or



purplish-brown *cacao-red*; fragments of epidermis of cotyledons with polygonal cells and reddish-brown granular contents.

**Purity Tests.**—The ether-soluble residue should not have a spicy odor or taste. The residue, insoluble in ether, shows microscopically few or no cocoa shells, and no cereal starch grains.

**Uses.**—Cocoa is used medicinally to mask the taste of bitter substances like quinine. Its chief use is as a nutrient beverage.

**Preparation.**—Cacao Syrup (Chocolate-flavored Syrup), N.F.

**Adulterant.**—Ground Cacao Shells which show numerous spiral tracheæ from the raphe, small beaker-shaped stone cells whose walls are lignified, fragments of mucilage cells, and diagonal "cross cells" of endocarp.



FIG. 277.—Cola (Kola Nut). Showing longitudinal section of fruit  $\times \frac{1}{4}$ ; cross-section of red seed  $\times \frac{1}{4}$ ; longitudinal section of red seed showing embryo  $\times \frac{1}{4}$ ; cross-section of red seed  $\times \frac{1}{4}$ ; longitudinal section of white seed. (Sayre after Kohler.)

ovate, acuminate. The flowers are yellow or purple of two kinds, staminate and pistillate and arranged in small axillary clusters. The fruit of *Cola acuminata* consists of 5 yellowish-brown woody follicles, each containing 1 to 3 white or red seeds.

**Production and Commerce.**—The trees are cultivated for the drug chiefly in the British West Indies and Africa.

Our commercial supplies are chiefly shipped to the U.S.A. in bags from Jamaica and Nigeria.

**Description.**—The drug occurs as entire or broken cotyledons, of irregularly plano-convex, broadly oval, or somewhat globular outline, up to 50 mm. in length and up to 25 mm. in diameter; heavy, hard and tough; externally brown, the outer surfaces slightly wrinkled, the inner surfaces lighter and smoother; edges slightly incurved and sharp; odor indistinct; taste slightly astringent.

#### KOLA N.F. (KOLA)

**Synonyms.**—*Cola*, *Kolanuts*, Gooroo Nuts, Bichy Nuts; *Ger.* Kolanuss; *Fr.* Noix de Gourou.

**Botanical Origin.**—*Cola nitida* (Ventenat) A. Chevalier, or other species of *Cola*.

**Part Used.**—The dried cotyledon.

**Standards.**—Not less than 1 per cent. of anhydrous caffeine, not more than 1 per cent. of foreign organic matter and not more than 0.5 per cent. of acid-insoluble ash.

**Habitat.**—Africa (Ivory Coast and Liberia). Cultivated from Sierra Leone to the Gaboon and in South America and West Indies.

**Plants.**—Large trees with smooth bark. The leaves are alternate, lance-

**Powdered Drug.**—Light brown to moderate yellowish-brown. Starch grains numerous, some unaltered, others altered, the unaltered grains up to  $45\mu$  in diameter, ellipsoidal, spherical, or irregularly oblong and occasionally with a protuberance on one side, the larger grains frequently exhibiting a circular central hilum or a fissure and showing a distinct polarization cross when examined under a petrographic microscope; parenchyma cells with reddish brown walls numerous.



FIG. 278.—Original burlap bags of Kola Nuts. (Courtesy of Parke, Davis and Company.)

**Constituents.**—1 to 2.5 per cent. of *caffeine*; a glucoside called kolatin (which on oxidation yields kola red), kolatein, *theobromine*, starch, fat, tannin and a lipase.

**Uses.**—Kola is used medicinally as a cerebral, cardiac and nerve stimulant. Large quantities are employed in the manufacture of summer beverages.

**Average Dose.**—4 Gm. (60 grains).

**Preparation.**—Fluidextract, 4 cc. (1 fl. dr.).

**Adulterants.**—*False Kola Nuts*, representing the seeds of *Heritiera littoralis* Dryand (Fam. *Sterculiaceæ*). These are sub-orbicular and flattened with purplish-brown cotyledons, one of which being about one-half the size of the other. They contain no caffeine.

The seeds of *Calocarpum Sapota* (Jacq.) Merrill (*Lucuma mammosa* Grise-

bach) (Fam. *Sapotaceæ*) which possesses a strong odor of hydrocyanic acid and are devoid of caffeine.

· STERCULIA GUM N.F. (GUMMI STERCULIÆ)

**Synonym.**—*Gum Karaya*.

**Definition.**—The dried gummy exudation from *Sterculia urens* Roxburg, *Sterculia villosa* Roxburg, *Sterculia tragacantha* Lindley, or other species of *Sterculia* (Fam. *Sterculiaceæ*), or from *Cochlospermum gossypium* De Candolle, or other species of *Cochlospermum* (Fam. *Bixaceæ*).

**Plants.**—The *Sterculia* species are tropical trees mostly native to Asia, but some occur in Africa, Australia and in tropical and subtropical America. Their leaves vary from entire to palmately lobed or divided. The flowers are unisexual or polygamous, each with a 5- to 4-cleft, frequently petaloid calyx but devoid of corolla and are arranged in panicles. The stamens are united into a column with a head of sessile anthers at the summit. The carpels are 4 to 5. The fruits are follicles.

*Cochlospermum gossypium* is a small tree native to India with palmately 3- to 5-lobed leaves which are tomentose beneath, golden yellow flowers in panicles, and many seeded capsular fruits.

**Commercial Sources.**—India, Anglo-Egyptian Sudan and Haiti.

**Description.**—It occurs in tears or in broken irregular pieces the latter some what crystalline-like and known commercially as "crystal gum," pale yellow to pinkish brown, translucent and horny, frequently admixed with darker fragments and occasional pieces of bark; odor slightly acetous; taste mucilaginous and slightly acetous.

**Powdered Drug.**—Light gray to pinkish gray. It swells in water but is insoluble in alcohol. When mounted in alcohol and examined microscopically, it exhibits irregular, polygonal, semi-transparent and colorless fragments of gum, and a few lignified stone cells, tracheae and fibers. An aqueous suspension (1 in 100) does not show a blue color when Iodine T.S. is added to it.

**Purity Rubric.**—Not more than 20 per cent of moisture, not more than 3 per cent of bark, not more than 1 per cent of acid-insoluble ash. 2 Gm. of Sterculia Gum should absorb not less than 50 cc. of water.

**Identity Tests.**—To an aqueous solution (suspension) (1 to 100), of Sterculia Gum, add a few drops of Millon's Reagent: a white curdy precipitate is produced.

Add 0.5 Gm. of Sterculia Gum to 50 cc. of diluted HCl and warm until hydrolyzed. To a portion of the resultant solution add an excess of NaOH and boil: a brown color and a fruity, characteristic odor are produced.

**Uses.**—In lotions and pastes; industrially as a size for paper, in printing gum, nicotine sprays, etc.

MALVACEÆ (MALLOW FAMILY)

Herbs in temperate regions (*Malva rotundifolia*, *Althæa officinalis*, etc.), occasionally shrubs in temperate regions (*Hibiscus Syriacus* or Rose of Sharon,

etc.), frequently shrubs or tall trees (*Gossypium arboreum* and *Thespesia*) in the tropics. Stems, as in *Sterculiaceæ* and *Tiliaceæ*, sometimes forming numerous layers of hard and soft bast. Leaves alternate and stipulate, ovate, ovate-cordate, orbicular, entire or variously lobed, with venation pinnate or palmate, often hairy, the non-glandular hairs being usually stellate. Stems, roots and leaves contain mucilage cells. Secretory cavities with brown contents have been observed in the axis and leaves of species of *Gossypium*, *Fugosia* and *Thespesia*. The phloem patches are cone-shaped and the primary medullary rays between these are wedge-shaped in their outer portion, as observed in cross section. Inflorescence a raceme or fascicle of cymes. Flowers regular, pentamerous; calyx green, of 5 or 3 aposepalous sepals, but frequently subtended by an involucre of bracteoles (epicalyx). Both calyx and epicalyx are persistent. Corolla of 5 petals, varying in color, which are more or less adnate at their bases to the staminal-column; stamens monadelphous and forming an upright staminal-column enclosing the styles; anthers 1-celled, dehiscing transversely; pollen grains echinate; pistil loosely or strongly syncarpous, rarely sub-apocarpous of thirty to five carpels. Fruit either a set of cocci united into a ring (*Althæa*, *Malva*), or a capsule (*Gossypium*). Seeds albuminous with oily and mucilaginous albumen.

#### ALTHEA N.F. (ALTHÆA)

**Synonyms.**—*Marsh Mallow Root*, *Mortification Root*, *White Mallow*; *Ger.* Eibischwurzel; *Fr.* Racine de Guimauve.

**Botanical Origin.**—*Althæa officinalis* Linné.

**Part Used.**—The dried root deprived of the brown, corky layer and small roots.

**Purity Rubric.**—It contains not more than 1 per cent. of foreign organic matter and not more than 1 per cent. of acid-insoluble ash.

**Habitat.**—Europe.

**Plant.**—A perennial herb with erect woody stems, 6 to 12 cm. high, alternate, ovate to slightly cordate, occasionally 3-lobed, serrate, velvety leaves and large, pale, rose-colored, axillary flowers, the calyx of each of which is surrounded by a 6 to 9 cleft involucre. The fruit is a set of cocci united into a ring.

**Production and Commerce.**—*Althæa* is native to Europe but has become naturalized in the United States where it grows wild in salt marshes near the coast of New England and along tidal rivers in New York and Pennsylvania. The roots which are rich in mucilaginous principles are collected in autumn from plants of the second year's growth, washed, peeled, cut into segments or cubes and carefully dried. The drug should be preserved against insect attack. Most of the article of commerce has been obtained from plants cultivated in France, Germany, Italy, Spain and Holland.

**Description.**—Marshmallow root occurs in small, more or less cubical-shaped pieces of grayish-white color and about 5 mm. in diameter (*cut althæa*), or as nearly entire roots or long segments thereof; when nearly entire, externally whitish, pale yellow to pale brown, longitudinally furrowed, often spirally

twisted and covered with somewhat loosened, hairy-like bast fibers; fracture of bark fibrous, of wood short and granular; internally yellowish-white; bark 1 to 2 mm. thick, porous, and separated from the slightly radiate wood by a distinct cambium zone; odor slight; taste sweet and mucilaginous.

**Histology.**—Transverse sections of the peeled root exhibit a comparatively narrow bark and broad wood zone separated from each other by a prominent cambium. The bark shows a little cortical parenchyma adhering here and there to the outside, the cells of which contain either ellipsoidal starch grains or rosette aggregates of calcium oxalate. The greater portion of the bark, however, consists of phloem patches separated by phloem medullary-rays. Each phloem patch shows alternating horizontally arranged layers of hard and soft



FIG. 279.—*Althaea officinalis*. Leaf and flowering branches.

bast. The former contain groups of thick-walled, more or less lignified and angular bast fibers, the latter, groups of sieve tubes, phloem cells with starchy or rosette crystal contents and mucilage cells. The contents of the mucilage cells take on a deep yellow color when sections are mounted in potassium hydroxide solution.

The wood is composed of numerous, irregular-shaped, radiating, xylem masses separated by wavy medullary-rays. Each xylem mass is composed of a matrix of wood parenchyma in which tracheæ are scattered singly and in smaller and larger groups. Each group of tracheæ is accompanied by narrow wood fibers. Most of the wood parenchyma cells contain ellipsoidal starch grains, others harbor rosette crystals of calcium oxalate, while many are modified as mucilage cells.

**Powdered Drug.**—White to weak yellow. Numerous fragments of parenchyma, the cells containing ellipsoidal starch grains or occasionally small rosette aggregates of calcium oxalate; numerous mucilage cells which are larger

than the other parenchyma elements; groups of sclerenchyma fibers with thick, lignified walls; fragments of bordered pored and scalariform tracheæ and tracheids; starch grains simple, ellipsoidal or pyriform, usually with indistinct hilum and up to  $30\mu$  in length; rosette aggregates of calcium oxalate few and up to  $35\mu$  in diameter.

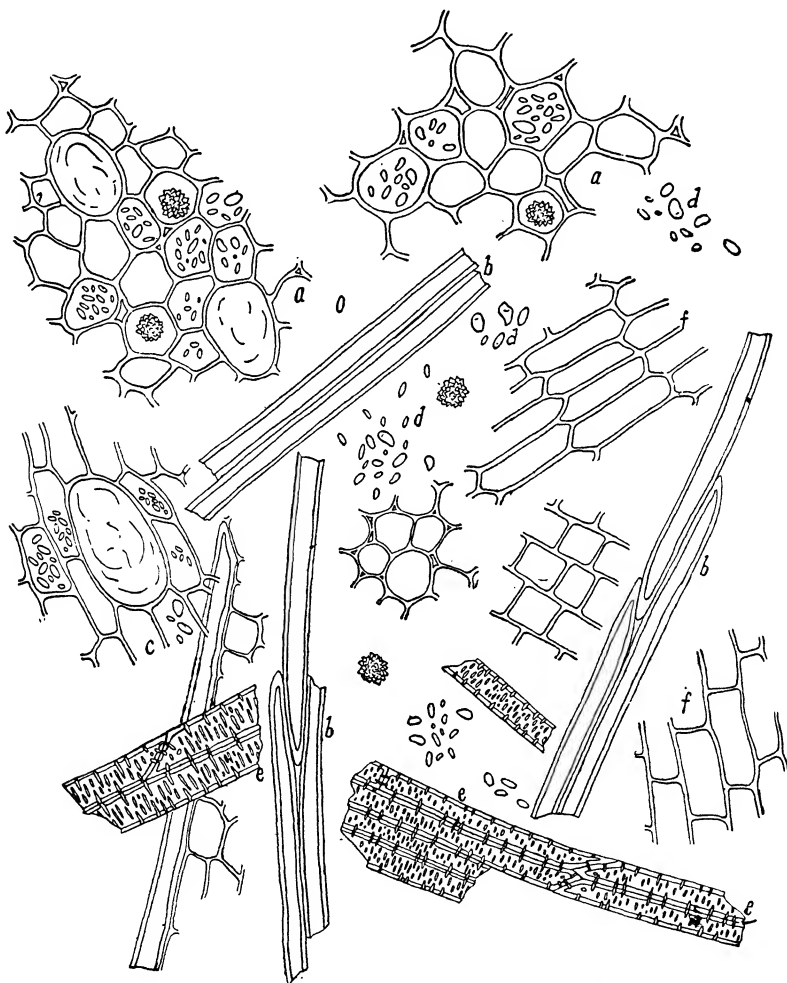


FIG. 280.—Powdered *Althæa*. (a) Parenchyma with mucilage cells, starch and rosette aggregate crystals; (b) bast fibers; (c) parenchyma, longitudinal view; (d) starch granules and crystals; (e) tracheids; (f) parenchyma, longitudinal view. (Schneider.)

**Constituents.**—Up to 35 per cent. of *mucilage*; starch, asparagin, pectin, sugar.

**Uses.**—Demulcent, poultice and pill excipient.

**N.F. Preparations.**—*Althea Syrup*, *Ferrous Carbonate Pills*, *Mercury Mass.*

**Substitutes.**—The roots of other *Malvaceæ*, especially the root of the Hollyhock (*Althæa rosea* Cav.).

## PURIFIED COTTON U.S.P. (GOSSYPIUM PURIFICATUM)

**Synonyms.**—*Absorbent Cotton*, Purified Cotton Wool; *Ger.* Baumwolle; *Fr.* Coton absorbant.

**Botanical Origin.**—Cultivated varieties of *Gossypium hirsutum* Linné or of other species of *Gossypium*.

**Part Used.**—The hair of the seed, freed from adhering impurities, deprived of fatty matter, bleached and sterilized.

**Habitat.**—Africa and Asia. Cultivated in the United States and in many other countries to the 40° latitude on either side of the equator.

**Plants.**—Annual or biennial herbs with long, branching tap root and branching stems, about 2 to 4 feet high under cultivation, pubescent; leaves palmately 3 to 4 lobed; flowers large, showy and yellow with a purple red blotch at the base of each petal (*G. barbadense*) or white, turning red on the second day of blooming (*G. hirsutum*) flowers. Each flower is subtended by an involucre of generally 3 bracts united at the base. The fruit is a 3- to 5-celled capsule which when mature dehisces, exposing a loose mass of white hairs, the outgrowth of numerous seeds.

**Production and Commerce.**—The absorbent cotton used in the United States is prepared chiefly, if not entirely, from the hairs of the seed of cultivated varieties of *Gossypium hirsutum* or American Upland Cotton and *G. Barbadense* or Sea Island Cotton. Both of these cottons are cultivated in the cotton belt of the South, although the culture of Sea Island Cotton is mostly confined to a small area along the coast of South Carolina, Georgia and Florida. It is estimated that 99 per cent. of the cotton crop in the United States is Upland Cotton.

The mature fruit of the cotton plant is a 3- to 5-celled, leathery capsule called a "boll." It splits open by 3 to 5 valves exposing a white fluffy mass, which consists of numerous seeds, each concealed within a dense covering of its hairs. The hairs are outgrowths or elongations of epidermal cells of the seed coat. There are generally 2 kinds of hairs on the seed, viz.: long hairs known as "fiber" or "staple" and short hairs or "fuzz." Cotton is picked when the bolls split and the fibers project in a twisted mass. It is placed in baskets which are emptied into wagons which carry it to the gin house. Here the cotton is ginned, a process whereby the raw cotton is separated from the seed and linters. Raw cotton is composed of a mass of hairs, each of which has oil globules and often other impurities adhering to it. Moreover, each raw cotton hair is covered with a waxy cuticle which is impermeable to water. In order to be of service as an absorbent in surgery it must be deprived of the oily material as well as its waxy cuticle and purified. This is accomplished by boiling the raw cotton under pressure with a dilute solution of caustic soda, washing in water to remove alkali, bleaching with chlorinated lime and hydrochloric acid, again washing and drying. The fibers are then loosened by a machine, and made into a light fluffy mass by further separating them with currents of air.

It is then packaged in tight rolls of not more than 1 lb. of a continuous lap

with a light weight paper running under the entire lap, the paper being folded over the edges of the lap, enclosed and sealed in a second well closed container, and sterilized.

**Description.**—A soft, white mass of fine filamentous hairs without odor or taste. Under the microscope each purified cotton hair appears as a hollow, flattened and twisted band with a thickened wall of cellulose and a broad lumen. With careful focusing with a high power objective, the wall shows spiral striations. Absorbent cotton is soluble in ammoniated cupric oxide test solution but insoluble in the ordinary solvents. Iodine solution imparts to cotton a yellow color which is changed to blue upon the addition of sulfuric acid.

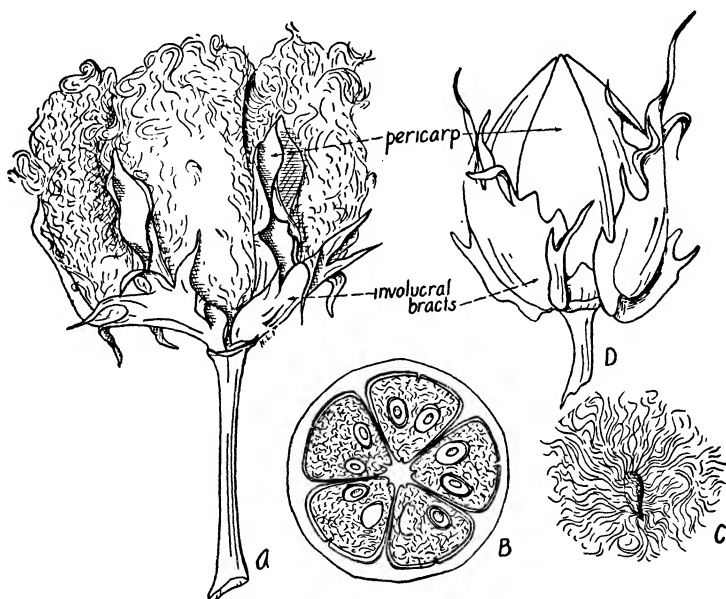


FIG. 281.—Upland cotton (*Gossypium hirsutum*). A, mature boll opened out; B, cross-section of young boll; C, single seed with hairs; D, young boll. (From Robbins "Botany of Crop Plants.")

**Standards.**—Ash not more than 0.2 per cent. of weight of cotton. Not less than 60 per cent., by weight, of the cotton fibers shall be 12.5 mm. (about  $\frac{1}{2}$  in.) or greater in length and not more than 10 per cent. by weight of the fibers shall be 6.25 mm. (about  $\frac{1}{4}$  in.) or less in length. It meets the requirements of the U.S.P. test for sterility of solids. Its absorbency is such that 5 Gm. when submerged in distilled water for 10 seconds and upon removal and draining for 10 seconds, retains not less than 24 times its weight of water.

**Constituent.**—Cellulose in its purest form.

**Uses.**—Absorbent cotton is employed as an absorbent and protective dressing in surgery and as a filtering medium in pharmacy. It is also used in the manufacture of **Pyroxolin** or **Soluble Gun Cotton, U.S.P.**, the latter entering into **Collodium, U.S.P.**



## COTTONSEED OIL U.S.P. (OLEUM GOSSYPII SEMINIS)

**Synonyms.**—Cotton Seed Oil, Cotton Oil; *Ger.* Baumwollsamööl; *Fr.* Huile de cotonnier.

**Botanical Origin.**—Cultivated plants of various varieties of *Gossypium hirsutum* Linné or of other species of *Gossypium*.

**Part Used.**—The refined, fixed oil obtained from the seed.

**Production and Commerce.**—The seed coats (hulls) are first removed and the oil expressed from the kernels. This first product is thick, dark, and cloudy and known as crude cottonseed oil. Crude cottonseed oil is clarified by boiling it with water to remove the mucilage and then warming it with a weak solution of sodium hydroxide or with sodium silicate (partial saponification) to remove the coloring matter, and cooled. The refined or bleached product is pale yellow and nearly tasteless. The seeds yield about 25 per cent. of oil which is of the semi-drying type. The residual cake left after expression of the oil from the kernels is used as a cattle food and fertilizer. The hulls are used for fertilizer and fuel.

**Description.**—A pale yellow, oily liquid, nearly odorless and with a bland taste; slightly soluble in alcohol but miscible with ether, carbon disulfide, chloroform and petroleum benzine; sp. gr. 0.915 to 0.921 at 25°C; iodine value 105-114; saponification value 190-198.

**Constituents.**—Chiefly *olein*. Cottonseed contains 20 to 25 per cent. of fixed oil, about 20 per cent. of proteids and 0.6 per cent. of a poisonous, crystalline, yellow, phenolic substance called *gossypol*, the latter occurring in secretory cells which are scattered through the cotyledons.

**Uses.**—Cottonseed oil is an emollient and nutrient. Pharmaceutically it is used in the preparation of liniments.

**Preparations.**—Camphor Liniment (Camphorated Oil), U.S.P.; Compound Tar Ointment, N.F.

## COTTON ROOT BARK N.F. (GOSSYPII RADICIS CORTEX)

**Synonyms.**—Gossypii Cortex; *Ger.* Baumwollwurzelrinde; *Fr.* Écorce de la racine cotonnier.

**Botanical Origin.**—Cultivated varieties of *Gossypium hirsutum* Linné, or of other species of *Gossypium*, especially *Gossypium Barbádense* Linné, and *Gossypium herbaceum* Linné.

**Part Used.**—The recently gathered, air-dried bark of the root.

**Purity Rubric.**—Not more than 5 per cent. of adhering wood or other foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—Asia and Africa. Cultivated in United States and many other countries.

**Production and Commerce.**—The drug should be made into fluid extract as soon after it is gathered as possible, for its yellow resin soon changes into an inert, brownish to reddish oxidized substance. The commercial supplies

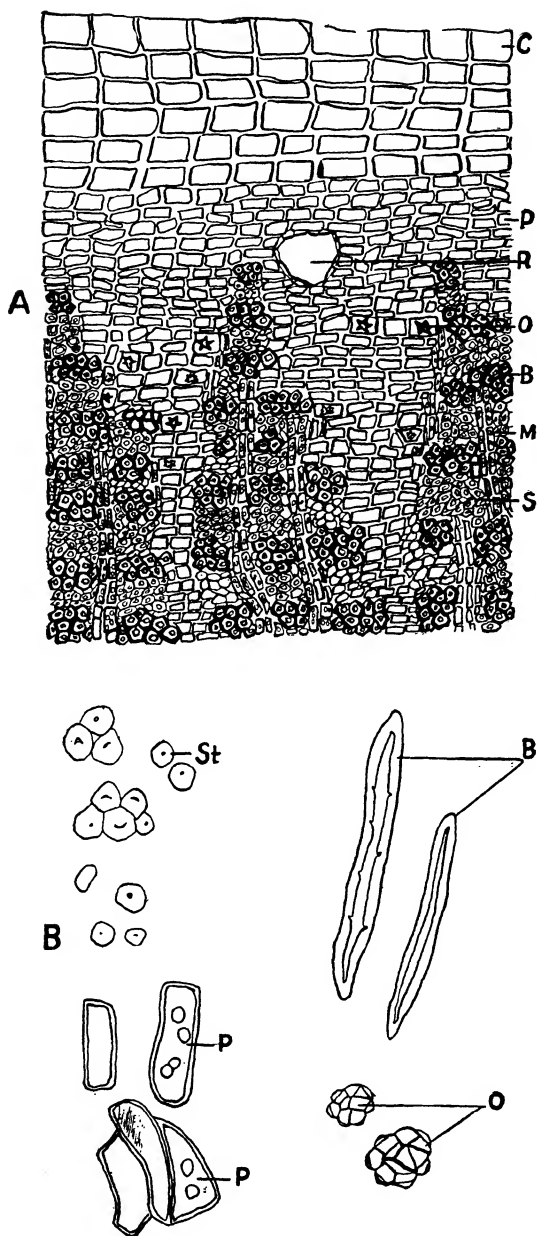


FIG. 282.—A, Transverse section of *Gossypii* Cortex (cotton root bark). Cork (C); cortical parenchyma, many of the cells containing tannin (P); secretory cavity (R) lined with epithelium and containing, in the freshly gathered bark, a pale yellow resin which darkens with age; rosette aggregate of calcium oxalate (O); bast fibers (B); soft bast (S); medullary-ray (M). B, Powdered cotton root bark. Starch grains (St); parenchyma containing starch (P); rosette aggregates of calcium oxalate (O).

are obtained from Virginia, the Carolinas and other Cotton growing states of the south.

**Description.**—In flexible bands or quilled pieces attaining a length of about 30 cm. and a thickness of about 1 mm.; outer surface weak brown to moderate yellowish-brown, smooth, or usually slightly longitudinally wrinkled with small circular lenticels, the cork and cortex frequently exfoliated and exposing the fibrous inner bark; inner surface light-brown to pale yellowish-orange, striated longitudinally; fracture tough, fibrous, the inner bark separating readily into fibrous layers; odor indistinct; taste slightly acrid.

**Histology.**—Passing from outer to inner surface, transverse sections reveal the following peculiarities:

1. *Cork* consisting of 4 to 6 layers of large, brick-shaped, yellowish-brown cells with thin walls.

2. *Cortex* of several layers of parenchyma containing mostly simple or 2-4 compound starch grains, the individual grains being more or less spheroidal and up to  $20\mu$  in diameter. Some cells in this region possess tannin contents others rosette crystals of calcium oxalate while here and there a few secretion reservoirs lined with epithelium and containing colorless to yellowish-orange contents may be observed.

3. *Phloem*, a broad zone of large, conical phloem patches, each of which is separated from its neighbor by a large, wedge-shaped, primary, starch-containing, medullary ray which broadens out toward the cortex. Each phloem patch is traversed by narrow, secondary phloem medullary rays and shows alternating, tangentially arranged groups of strongly lignified bast fibers and soft bast. Some of the phloem cells in the soft bast regions contain rosette aggregates of calcium oxalate, others starch grains.

**Powdered Drug.**—Light yellowish brown. Numerous bast fibers up to  $1000\mu$  in length and about  $15\mu$  in width with strongly lignified walls, the latter about  $5\mu$  in thickness and with few pores, the ends of the fibers acute and attenuate; numerous fragments of cortical parenchyma containing simple spheroidal and compound starch grains, the individual grains up to  $20\mu$  in diameter, the tissue occasionally enclosing a secretion reservoir; fragments composed of starch-containing medullary-ray cells; rosette crystals of calcium oxalate from 9 to  $25\mu$  in diameter.

**Constituents.**—Up to 10 per cent. of a colorless to yellow *acid resin* (containing 2 phenolic substances, a phenolic acid and salicylic acid) which becomes reddish, water-insoluble, and inert upon exposure to the air; fixed oil, starch, calcium oxalate, etc.

**Uses.**—Emmenagogue and oxytocic.

**Average Dose.**—2 Gm. (30 grains).

**Preparation.**—Fluidextract (unof.) 2 cc. (30 minims).

#### THEACEÆ (TERNSTRÆMIACEÆ, CAMELLIACEÆ OR TEA FAMILY)

Evergreen shrubs or low branching or tall, often heavy trees with watery juice. Leaves for the most part alternate, evergreen, often leathery, sometimes

membranous; stipules either bud scales and caducous or often absent; leaf margins sinuate or serrate (*Tea*). Inflorescence a raceme becoming by condensation terminal, one-flowered. Flowers regular, perfect, pentamerous; sepals five, rarely four to three, deciduous, occasionally subtended by bracteolar scales; petals five, brittle and succulent, varying from greenish-white or greenish-yellow through yellow to white or, from whitish-pink to pink, scarlet, crimson, very rarely a tendency toward purple; stamens typically five but, as they grow, they subdivide into staminal leaflets so that in their mature condition they are apparently indefinite and mono- to polyadelphous; stamens inserted hypogynously or perigynously and opposite the petals; pistil of typically five syncarpous carpels but reduced in some species to four to three or two. Fruit usually a capsule (*Camellia*), five- to three-celled, dehiscent longitudinally, more rarely a fleshy, semi-baccate, semi-drupaceous indehiscent fruit. Seeds with scanty or no albumen and often attached to inner angle of cells by projecting spongy placentæ.

#### TEA (THEA)

**Synonyms.**—Tea Leaves; *Fr.* Thé; *Ger.* Thee.

**Botanical Origin.**—*Camellia sinensis* (L.) O. Kuntze (*Thea sinensis* L.) and its varieties (*Bohea*, *viridis*, *stricta* and *lasiocalyx*).

**Part Used.**—The prepared leaves and leaf buds.

**Habitat.**—Southern Asia, probably Assam.

**Plants.**—Evergreen shrubs, 3 to 5 feet high with alternate, elliptical or oblong-lanceolate, shiny, coriaceous, short petiolate, serrate leaves, white axillary flowers, and capsular fruits.

**Production and Commerce.**—The plants are extensively cultivated for the leaves in China, Japan, Formosa, India, Ceylon, Java and Brazil. They are propagated from seed sown in autumn in shaded seed beds. The young seedlings are transferred to the field in from one to two years and begin to yield the third year, although a good crop is not harvested until the plants are from 5 to 10 years old. They continue to yield for 50 years or longer. The shrubs are kept well pruned so as to make their young shoots within easy reach of the pickers. The tea leaves are gathered only during the active growth of the shoots and usually only the terminal portion of the shoot bearing 1 or 2 leaves and the buds are taken for the better grades of tea, the older leaves yielding inferior grades. There are two classes of teas, black tea and green tea. In the preparation of black tea, the tender leaves and leaf buds are plucked with the terminal portion of the shoot bearing them, thrown into baskets and taken to the factory where they are spread out thinly on trays and racks to wither for about a day or until they become sufficiently soft for rolling. They are then rolled to remove the juice, passed through a rotary machine, spread out in layers about 2 in. thick in a cool room, allowed to undergo fermentation for a period, and then again rolled. They are then exposed on wire network trays to a high temperature until they become firm and crisp. The shoots carrying the buds and leaves are then broken apart and sorted by means of mechanical sifters

into the various grades such as Pekoe, Orange Pekoe, Souchongs, Congu, etc. After sifting they are basket or pan fired at 70 to 80°C. and packed and sealed in air-tight chests which are lined with lead.

In the preparation of green tea, the withering and fermenting steps are omitted and the leaves are exposed to hot steam or pan heated to destroy enzymes (oxidases) and dried quickly. Flowery Pekoe tea represents leaf buds, Pekoe, first leaf, first grade Souchong, second leaf, third grade Souchong the third leaf, Congu, the fourth leaf. Some grades are mixed with the sweet-scented flowers of jessamine, orange, gardenia, etc. or placed in contact with these. There are numerous varieties and blends of teas on the market. The

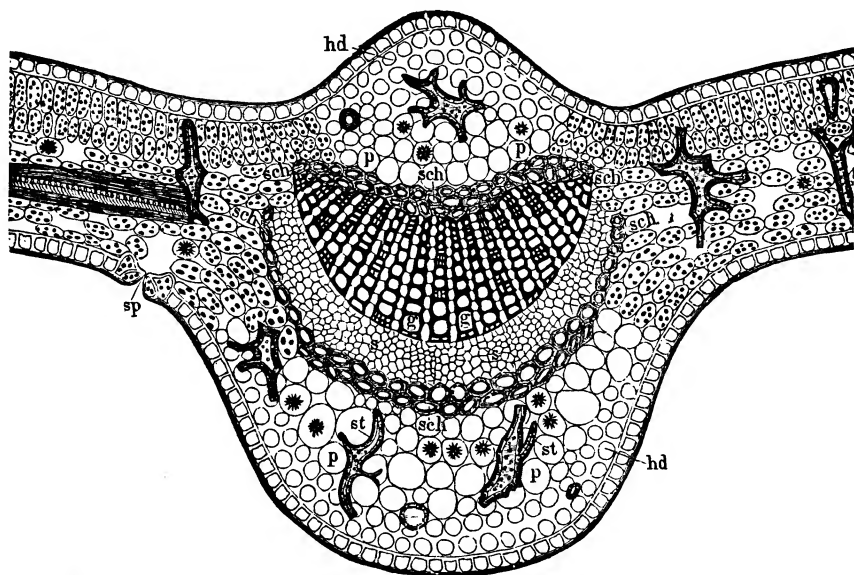


FIG. 283.—Tea. Transverse section through midrib. *hd*, collenchyma, *g*, tracheæ in xylem; *p*, parenchyma; *s*, sieve tissue; *sch*, sclerenchyma fibers in pericycle; *sp*, stoma; *st*, idioblasts,  $\times 130$ . (From *Greenish's Microscopical Examination of Foods and Drugs*, after *Warnecke*.)

commercial supplies are chiefly obtained from China, Japan, Formosa, India and Ceylon.

**Description.**—Usually in rolls or balls or crumpled masses, when entire nearly elliptical or oblong-lanceolate, short petiolate, summit acute or emarginate, base nearly spatulate tapering into a short petiole; margin serrate or nearly entire; color greenish or blackish green. Upper surface glabrous, lower surface smooth or hairy; more or less leathery; odor agreeably aromatic; taste bitter and astringent.

**Histology.**—The diagnostic histological elements found in tea are large, elongated, irregular, colorless idioblasts (stone cells), numerous elongated unicellular, thick-walled, non-glandular hairs  $10\mu$  wide and about 1 mm. long with pointed apex and frequently bent base; rosette aggregates of  $\text{Ca}\bar{\text{O}}$ , and stomata with 3-4 neighboring cells.

**Adulterants.**—1. Other *Camellia* leaves: Lower epidermis thick-walled and more or less papillose. Idioblasts same as in tea.

2. *Acer Negundo* Leaves.—Non-glandular hairs and glandular hairs, the glandular hairs with a 2-3 celled stalk and large 1-celled head.

3. *Cherry Leaves* (*P. avium*).—Possess numerous small rosette aggregates of  $\text{CaO}$  in lower epidermal cells.

4. *Gromwell leaves* (*Lithospermum officinale*) have stiff, scythe-shaped hairs.

5. *Ash leaves* (*Fraxinus* spp.) have horned stomata, due to increased thickenings of the cuticle at the opening of the stomata. Epidermal cells very wavy in outline.

6. *Mulberry leaves* (*Morus alba* and *Morus nigra*) have cystoliths in the epidermal cells, non-glandular and glandular hairs, the latter with a unicellular stalk and a 5 to 9 celled glandular head.

7. *Strawberry leaves* (*Fragaria vesca*) exhibit long, unicellular, non-glandular hairs, the basal portions of which have thick walls with simple pores. Glandular hairs with 3-celled stalk and large head.

8. Leaves of *Willow Herb* (*Epilobium angustifolium*) contain numerous raphides and the non-glandular hairs are slightly wavy, rather broad and with rounded ends. Water stomata occur beneath teeth.

9. *Willow leaves* (*Salix*) exhibit small stomata with 2 accompanying cells, the hairs are crooked and with thin walls.  $\text{CaO}$  in rosettes and monoclinic prisms.

10. *Wistaria* (*Kraunkhia floribunda*) leaflets have non-glandular hairs with pointed, distal cell.

11. Exhausted tea leaves and stems.

**Constituents.**—Up to 4 per cent. of *caffeine* (theine); *gallotannic acid*, gallic acid, resin, volatile oil, traces of *theobromine*, *theophylline*, adenine, etc.

**Uses.**—Tea is used as a cerebral and cardiac stimulant and as a source of caffeine and theophylline. Much of the caffeine of commerce is made from tea siftings.

**Caffeine U.S.P.** or Trimethylxanthine ( $\text{C}_8\text{H}_{10}\text{O}_2\text{N}_4$ ) occurs in white, glistening needles, usually matted together, and has a bitter taste; 1 Gm. is soluble in 46 cc. of water and 66 cc. of alcohol at  $25^\circ\text{C}$ . It is also found in coffee, guarana, cassine, Paraguay tea or maté and in cacao seeds. It is a cerebral, cardiac, vasomotor and respiratory stimulant and diuretic. Average dose, 0.2

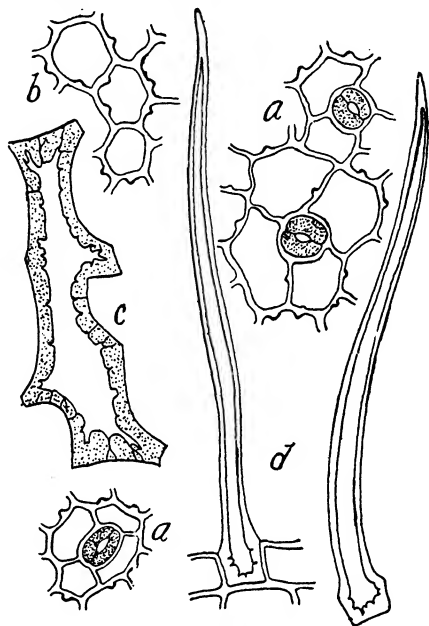


Fig. 284.—Powdered Tea. *a*, lower epidermis showing stomata; *b*, upper epidermis; *c*, branching stone cell from mesophyll of leaf; *d*, trichomes. (After Schneider.)

Gm. (3 grains). Av. dose of Citrated Caffeine U.S.P., 0.3 Gm. (5 grains); of Caffeine and Sodium Benzoate U.S.P., by mouth or intramuscular, 0.5 Gm. (7½ grains). Caffeine and Sodium Benzoate Injection U.S.P. is a sterile solution of caffeine and sodium benzoate in water for injection. Tablets of Caffeine and Sodium Benzoate, N.F., each tablet containing 5 grains.

**Theophylline U.S.P.** or Dimethylxanthine ( $C_7H_8N_4O_2 \cdot H_2O$ ) is a white, crystalline, odorless powder with a bitter taste. 1 Gm. is soluble in about 120 cc. of water and in 80 cc. of alcohol. It is used as a diuretic, chiefly in heart disease and dropsy. Average Dose: 0.2 Gm. (3 grains). **U.S.P. Preparations:** Theophylline Tablets, Theophylline and Sodium Acetate, 0.2 Gm. (3 grains), Mersalyl and Theophylline Injection, Intramuscular, an amount equivalent to Mersalyl 0.2 Gm. and Theophylline 0.1 Gm.

**Aminophylline U.S.P.** (Theophylline Ethylenediamine) is a mixture of theophylline and ethylene diamine. It occurs as white or slightly yellowish granules having a slight ammoniacal odor and a bitter taste. 1 Gm. is soluble in about 5 cc. of water. Diuretic and cardiac stimulant. Average dose, Oral, 0.2 Gm. (3 grains), Intramuscular or intravenous, 0.25 Gm. (4 grains). U.S.P. Preparations: Injection and Tablets.

#### GUTTIFERÆ (GAMBOGE FAMILY)

Tropical trees (*Garcinia* spp. including the Mangosteen, Mamey and Gamboge), rarely shrubs, containing resinous principles in schizogenous resin canals found in cortex, pith of stems, leaves, and in mesocarp of fruits. Leaves opposite, coriaceous. Flowers dioecious, generally pentamerous or tetramerous with usually five stamens which are subdivided. Fruit a berry (*Garcinia Hanburyi*), drupe or capsule. Seeds generally large; embryo large to huge, often with enlarged radicle and reduced or absorbed cotyledons.

#### GAMBOGE N.F. (CAMBOGIA)

**Synonyms.**—Pipe Gamboge, Gutta Gamba, Cambodia; *Ger.* Gummigutt; *Fr.* Gomme gutte.

**Part Used.**—A gum resin.

**Botanical Origin.**—*Garcinia Hanburyi* Hooker filius.

**Standards.**—Not less than 65 per cent. of anhydrous alcohol-soluble extractive, not more than 1 per cent. of acid-insoluble ash and not more than 1 per cent. of foreign organic matter.

**Habitat.**—Siam, Cochin China and Annam.

**Plant.**—*Garcinia Hanburyi*, the Siam Gamboge tree, is a spreading tree with orange-brown bark, opposite, ovate, leathery leaves and small, yellow, axillary clusters of dioecious flowers. The fruit is an orange-green, oily berry about the size of a crab apple that has 4 locules, each containing a seed.

**Production and Commerce.**—The gum-oleo-resin constituting the drug occurs as a yellowish juice in schizogenous resin canals which are found in cortex, phloem, pith, leaves, flowers and fruit. It is collected from January to

May be natives, mainly in Cochin China and Siam, by making spiral incisions into the bark of the trunk from the ground upward to the lower branches. The juice exudes and is collected in hollow internodes of bamboo stems, allowed to harden, the stems then heated until they crack, when the gamboge is readily removed. The drug is purchased by collectors and sent to Bangkok or Saigon. Most of the drug is exported from Singapore in the form of "pipes" packed in cases. Smaller amounts come from Bangkok and London.

**Description.**—In hard, cylindrical, brittle sticks, from 2 to 5 cm. in diameter, and of variable length; externally weak reddish-brown to dark orange, longitudinally striate; fracture brittle, conchoidal, the fractured surface smooth, orange red; odorless; taste very acid. When triturated in a mortar with water

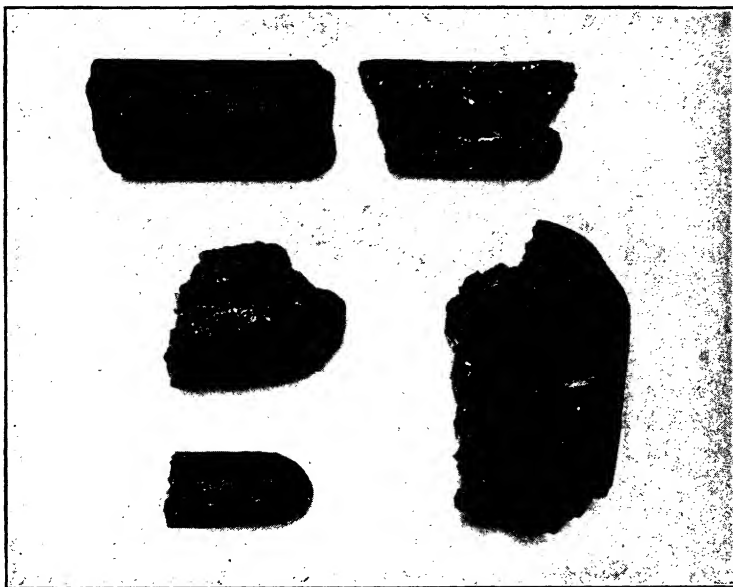


FIG. 285.—Gamboge, in broken pipes,  $\times 1\frac{1}{2}$ . (Photograph by Stoneback.)

it yields a yellow emulsion which darkens and becomes almost transparent upon the addition of ammonia water. The emulsion should not become green upon the addition of iodine T.S. (*starch test*).

**Powdered Drug.**—Moderate yellowish-orange, odorless, taste acid. Chloral mounts exhibit scattered fragments of vegetable tissues. Few or no starch grains should be evident. Most of the powdered drug dissolves in chloral hydrate solution.

**Constituents.**—A resin called *camboic acid* (70 to 80 per cent.), a water-soluble gum (15 to 25 per cent.), an oxidase enzyme, volatile oil, etc.

**Uses.**—Gamboge is employed medicinally as a hydragogue cathartic. It is also used by violin makers in preparing a stain for their wood.

**Average Dose.**—Adults, Human, 0.125 Gm. (2 grains). Cattle, 15 Gm. ( $\frac{1}{2}$  oz.).



**Adulterants.**—Cereal flours particularly wheat and rice, sand, and vegetable fragments.

**Preparation.**—Compound Mild Mercurous Chloride Pills (Compound Cathartic Pills), 2 pills.

#### CANELLACEÆ (CANELLA FAMILY)

Trees, the bark of which contains aromatic principles. Leaves alternate, pellucid-punctate. Flowers regular, golden-yellow, or white, and arranged in terminal or axillary cymes. Fruit a berry containing two to many seeds with oily and fleshy albumen. The histological features include secretory cells in the parenchyma of the roots, stems and leaves, wood prosenchyma with bordered pits, end walls of vessels with scalariform perforations, and bordered pits even where in contact with medullary-ray cells, calcium oxalate in rosette aggregates and solitary prisms, sub-epidermal cork formation and the development of a phelloderm consisting of cells with their walls lignified on one side only.

#### CANELLA (CANELLA)

**Synonyms.**—White Cinnamon, Cinnamon Canella. *Fr.* Cannelle blanche; *Ger.* Weisses Zimmt.

**Botanical Origin.**—*Canella Winterana* Linné (Gaertner).

**Part Used.**—The dried rossed bark.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter.

**Habitat.**—West Indies.

**Commercial Source.**—Nassau, on island of New Providence, West Indies.

**Plant.**—A tree of medium height with ash-gray bark, alternate, coriaceous, pellucid-punctate leaves and white flowers.

**Description.**—In quills usually from 1 to 3 cm. in length and from 1 to 4 cm. in thickness, occasionally two or three times this size, or in irregular fragments of quills, from 1.5 to 5 mm. in thickness and 2 to 3 cm. in width, the outer periderm mostly removed; outer surface light brownish-yellow or pale orange-brown, more or less scaly, with a few very shallow fissures, often more or less reticulate with slight ridges; inner surface paler, somewhat smooth, but showing coarse, longitudinal striæ; fracture short and granular, pale yellow, with an irregular, slightly darker band just inside of the center. Odor slight unless the bark is heated, then aromatic, resembling that of cinnamon; taste aromatic, warm, somewhat bitter and mucilaginous.

**Powdered Drug.**—Light brown to brownish-red; numerous, isodiametric, thick-walled stone cells, the walls with simple or branching pores; calcium oxalate in rosette aggregates up to  $50\mu$  in diameter; starch grains simple or two- to three-compound up to  $20\mu$  in diameter; oil cells with suberized walls numerous.

**Constituents.**—Resin, *bitter principle*, *volatile oil* containing eugenol, cineol and terpenes; mucilage, starch, etc. No tannin.

**Uses.**—Aromatic bitter and condiment; a constituent of *Hiera Picra*, N.F. V.

**Average Dose.**—2 Gm. (30 grains).

## FLACOURTIACEÆ (FLACOURTIA FAMILY)

A family of chiefly tropical trees and shrubs with simple, alternate leaves, staminate, pistillate and hermaphrodite flowers, frequently dioecious or polygamous, with a 1-celled ovary. The fruits are either berries, drupes or rarely capsules. The seeds are albuminous.

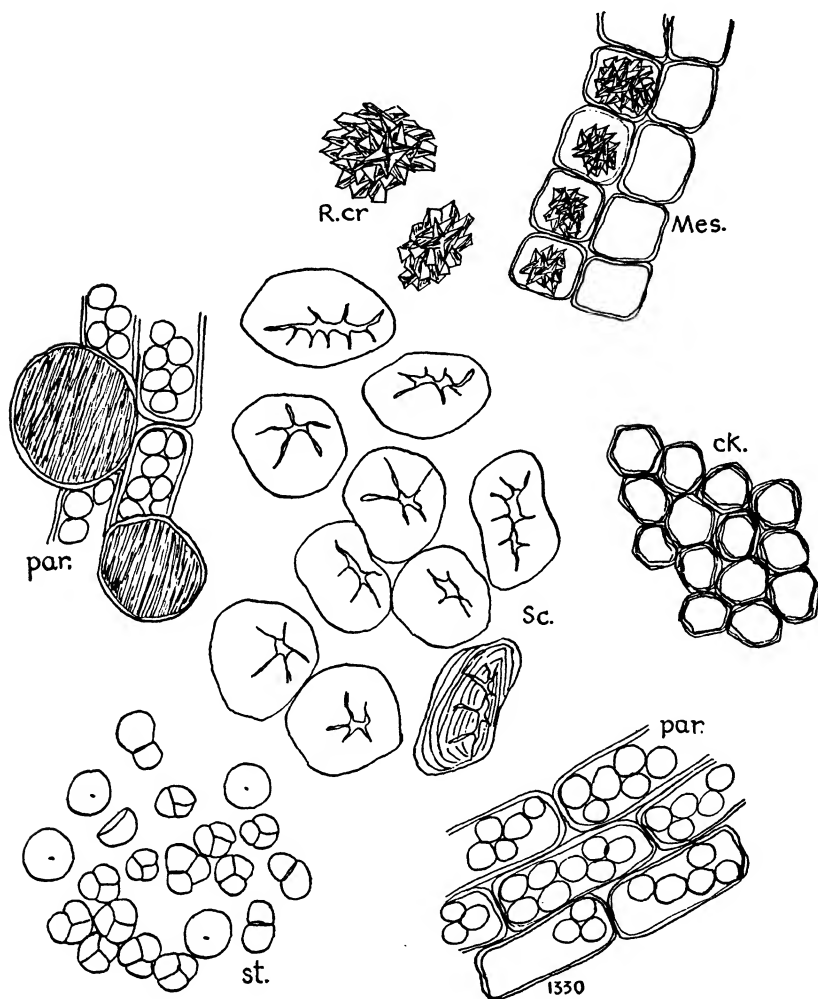


FIG. 286.—Powdered Canella. *ck.*, cork; *mes.*, medullary ray cells containing rosette aggregates of calcium oxalate; *r.cr.*, rosette aggregate crystals; *sc.*, stone cells; *par.*, parenchyma, the fragment on left with 2 large spheroidal oil cells; *st.*, starch grains.

## CHAULMOOGRA OIL N.F. (OLEUM CHAULMOOGRÆ)

**Synonyms.**—*Hydnocarpus* Oil, Kalaw Tree Oil, Leprosy Oil.

**Botanical Origin.**—(1) *Taraktogenos Kurzii* King, (2) *Hydnocarpus Wightiana* Blume or (3) *Hydnocarpus anthelmintica* Pierre.

**Part Used.**—The fixed oil expressed from the ripe seed.

**Habitat.**—(1) Burma. (2) India. (3) Cochin China.

**Plants.**—*Taraktogenos Kurzii*, known to the Burmese as “Kalawso,” is a tree attaining the height of 40 to 50 ft. whose young branches, leaves and flower clusters are tawny-pubescent, the trunk and older branches being covered with a greenish-gray, rusty-lenticellate bark. Its mature leaves are alternate, lanceolate or oblong-lanceolate or occasionally elliptic, shiny, subcoriaceous, with 6 to 7 pairs of main nerves and up to 10 in. in length. The inflorescence is a many-flowered axillary cyme. The staminate flowers which alone have been described by King are said to be about 3 in. in diameter and possess 4 ovate sepals, 8 broadly ovate petals having ciliate edges and 24 stamens. The fruit is a fawn-colored, globular berry about the size of an orange with a minutely granular, velvety rind and containing numerous irregularly oval, brownish-yellow seeds imbedded in a fleshy pulp.

*Hydnocarpus Wightiana* is a tall tree with thinly coriaceous, elliptic to oblong-lanceolate often deeply serrate leaves, racemes of white flowers and tomentose berry fruits up to 4 in. in diameter. It is native to India.

*Hydnocarpus anthelminthica*, known as the Chaulmoogra oil tree of Siam, is an erect tree native to Cochin China, possessing fibrous bark, the fibers used for cordage. Its leaves are coriaceous, entire, rounded obtuse at the base and attenuated-obtuse at the summit with 8 to 10 pairs of lateral nerves and oblique veins forming a close net. It bears axillary clusters of rose-colored flowers. Its fruit is a globular berry containing 30 to 40 angular seeds. This species yields the *krabao oil* of commerce. It has been introduced into Malaya where it is under cultivation at Serdang.

**Production and Commerce.**—The seeds of *Taraktogenos Kurzii* are collected by the natives of the Chittagong hills of Burma from the ripe fruits and sent to Calcutta where they are washed, dried in the sun, shelled and subjected to hydraulic pressure for the expression of the fixed oil. The kernels yield from 25 to 30 per cent. of fixed oil. The cold drawn oil is then filtered. Oil containing chaulmoogric and hydnocarpic acids is also obtained from the ripe seeds of other species of *Hydnocarpus* and can be legitimately used as Chaulmoogra oil, if conforming with the latter in physical properties, description, and meeting the requirements of the tests prescribed in the N.F. monograph, and its source be designated. The commercial supplies come from India or indirectly through London.

**Description.**—A yellowish or brownish-yellow liquid, or, at temperatures below 25°C., a whitish, soft solid; odor characteristic; taste somewhat acrid; sparingly soluble in alcohol; soluble in ether, chloroform, benzene and petroleum benzene; sp. gr. 0.940 to 0.960 at 25°C.; saponification value 196 to 213; iodine value 93 to 104.

**Constituents.**—*Chaulmoogric acid* ( $C_{18}H_{32}O_2$ ), *hydnocarpic acid* ( $C_{18}H_{28}O_2$ ), taraktogenic acid, isogadoleic acid, etc.

**Uses.**—Chaulmoogra oil is employed as a germicide in the treatment of leprosy. It has also been used empirically in rheumatism, psoriasis and tuber-

culosis, as a counterirritant application for sprains and bruises and also for various inflammations of the skin. It is the source of Ethyl Chaulmoograte N.F., which is employed for the same diseases. **Ethyl Chaulmoograte** (*Aethylis Chaulmoogras*) consists of the ethyl esters of the mixed acids of chaulmoogra oil.

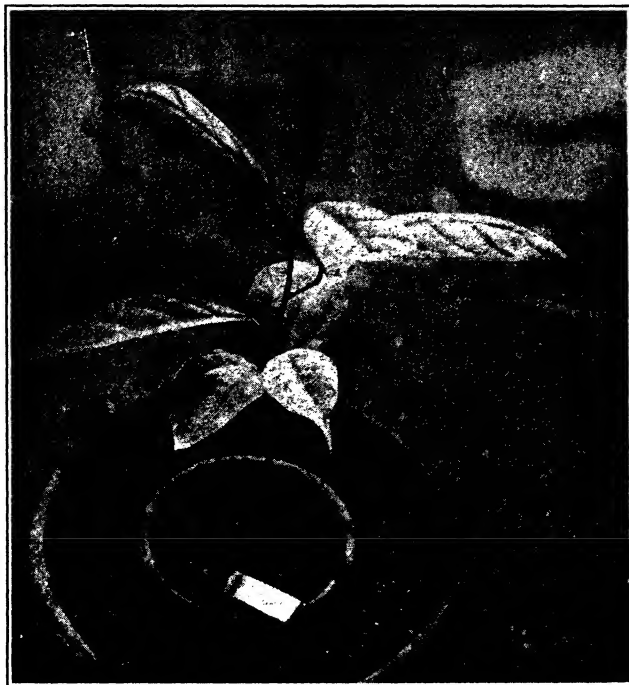


FIG. 287.—*Taraktogenos Kurzii* (Chaulmoogra-oil tree). Young tree grown by the author in the garden of The Philadelphia College of Pharmacy and Science at Glenolden, Pa.

**Average Dose.**—Chaulmoogra oil, 1 cc. (15 minims); of ethyl chaulmoograte, 2 cc. (30 minims).

#### PASSIFLORACEÆ (PASSION FLOWER FAMILY)

Herbaceous or woody vines climbing by tendrils. Leaves alternate, simple, entire, lobed or compound. Flowers perfect or imperfect, solitary; peduncles jointed at the flowers; perianth petaloid with urceolate or tubular tube and four to five or eight to ten partite and two-seriate limb, the throat usually crowned by one or more series of subulate filaments which are frequently colored; gynophore elongating, supporting the stamens and pistil. Fruit a one-celled berry (*Passiflora*), or a 3- to 5-valved, dehiscent capsule containing numerous seeds.

#### PASSIFLORA (PASSION FLOWER)

**Synonyms.**—Passion Vine, Wild Passion Flower, May-pop.

**Botanical Origin.**—*Passiflora incarnata* Linné.

**Part Used.**—The dried flowering and fruiting top.

**Habitat.**—In dry soil of the southern United States; Virginia to Florida, west to Texas and Missouri.

**Plant.**—A perennial herb, climbing by means of axillary tendrils; leaves alternate, palmately 3- to 5-cleft with serrate lobes; flowers large, solitary, long peduncled, whitish, with a triple purple and pink crown; fruit an ovate berry containing numerous ovoid, flattened seeds that are covered with a yellowish or brownish aril.

**Production and Commerce.**—The drug is gathered in summer when in flower and fruit and carefully dried. The commercial supplies come chiefly from Virginia and North Carolina.

**Description.**—Stems subcylindrical, glabrous or slightly pubescent above, longitudinally striate, woody and hollow, the cavity above one-half the diameter; bark thin, greenish or purplish; wood porous and showing on its inner margin a thin layer of pith. Leaves more or less broken, greenish-brown, thick; when entire, palmately 3-5 cleft; base cordate, apex acute, margin of lobes serrate; petioles up to 5 cm. in length with 2 nectar-glands near the summit. Tendrils numerous and closely coiled. Flowers solitary, axillary, peduncles as long as the petioles, usually with an involucre of 3 bracts, calyx cup-shaped of 5 sepals; corolla of 4 to 5 yellow petals inserted on the calyx; corona of the fresh flowers purple and pink; stamens 5, monadelphous; ovary unilocular, superior; fruit an ovoid, many seeded berry, about the shape and size of a pullet egg; externally green or yellow, somewhat shrivelled; seeds flat, ovate, each with a yellow or brown arillus; odor slight, taste slightly acid.

**Constituents.**—*Water-soluble depressor material* (Fellows and Smith), *catechol*, *gallic acid*, palmitic, myristic, oleic, linoleic and linolenic acids, melissyl alcohol, sitosterol and glucose.

**Uses.**—Motor depressant in neuralgia; also employed in insomnia, dysmenorrhœa and diarrhœa.

**Average Dose.**—0.2 Gm. (3 grains). **Preparation.**—Tincture, 1 cc.

#### CARICACEÆ (PAPAW FAMILY)

A small tropical American family of trees and shrubs containing a milky juice. Leaves in a terminal cluster, alternate, exstipulate and usually palmately lobed. Flowers pentamerous, staminate, pistillate and hermaphrodite, racemose, the pistillate and hermaphrodite with a superior 1- to spuriously 5-celled ovary containing numerous ovules. Fruit a berry. Seeds albuminous. Laticiferous tubes occur in roots, stems, leaves and fruits.

#### PAPAIN N.F. (PAPAIN)

**Synonyms.**—Papayotin, Papoid.

**Botanical Origin.**—*Carica Papaya* L.

**Part Used.**—The dried and purified latex of the fruit.

**Standard of Assay.**—It possesses a digestive activity not less than that of Reference Papain.

**Habitat.**—Tropical America. Naturalized in Southern Florida.

**Plant.**—A tree attaining the height of about 20 ft. with large, long petioled, palmately 7-lobed leaves whose lobes are in turn divided into secondary lateral lobes. The inflorescences consist of racemose cymes of yellow, staminate and pistillate flowers. The fruit is a large melon-like, edible berry up to about 15 lbs. in weight and with a salmon-pink or yellow flesh and a central cavity in which are found numerous blackish spheroidal seeds. (See Fig. 288.)

**Production and Commerce.**—The Papaw is widely cultivated in tropical America, in Hawaii and other tropical countries for its fruits and leaves which with other parts of the plant contain the proteolytic enzyme, papain. Papain is obtained commercially by slashing the fruits and collecting the latex in porcelain-lined receptacles wherein it is permitted to evaporate until it has become granular. This constitutes the crude papain of commerce. From this the purified article (papain, papoid or papayotin) is prepared by dissolving it in water and precipitating with alcohol and drying.

**Description.**—It occurs as light brownish-gray to weak reddish-brown granules or as a yellowish-gray to weak yellow powder with a characteristic odor and taste.

**Constituents.**—The latex of Papaw contains about 5 per cent. of the proteolytic enzyme, *papain*; a *rennin-like enzyme*, an *amylolytic enzyme*, a *lipase* and pectase; traces of the alkaloid carpaine, the enzyme *chymopapain*, etc.

**Use.**—Digestant. The leaves and green fruits are eaten by the natives as vegetables. Commercial Papain is used in preparations for tenderizing meat. Dose of papain, 5 to 10 grains.

#### CACTACEÆ (CACTUS FAMILY)

Herbaceous, rarely arborescent (*Cereus giganteus*), more or less succulent plants living in warm, dry (*Pereskia*), usually desert situations, rarely becoming epiphytic and correspondingly modified. Stems accordingly varying from elongate, slightly enlarged, green (*Pereskia*), to flattened and ribbed (*Selenicereus*), to flattened and shortened (*Opuntia*), to condensed (*Echinocactus*, *Echinocereus*, etc.), to greatly condensed (*Mamillaria*). Leaves alternate, stipulate or exstipulate, thick, enlarged and more or less fleshy (*Pereskia*), becoming reduced, green, semicircular and falling off early in *Opuntia*, or modified into spines, or wholly absorbed. Stems and leaves possess numerous mucilage sacs and crystals of calcium oxalate. Flowers, regular, solitary, or fascicled, in axils of leaves; sepals five; petals similar to sepals, petaloid, small to much enlarged, in color varying from yellow to white or from yellow to yellowish-pink, pink, scarlet or crimson; stamens indefinite, inserted at varying levels in the throat of a greatly expanded up-grown receptacle; pistil generally tricarpeal; ovary inferior, often deeply sunk in up-grown receptacular part; style thread-like, divided above into as many stigmas as carpels. Fruit a receptacular berry enclosing numerous small seeds. Seeds exalbuminous.

**Cactus Grandiflorus** or Night-blooming *Cereus* consists of the fresh succulent stem of wild growing *Selenicereus grandiflorus* Britton and Rose, a perennial

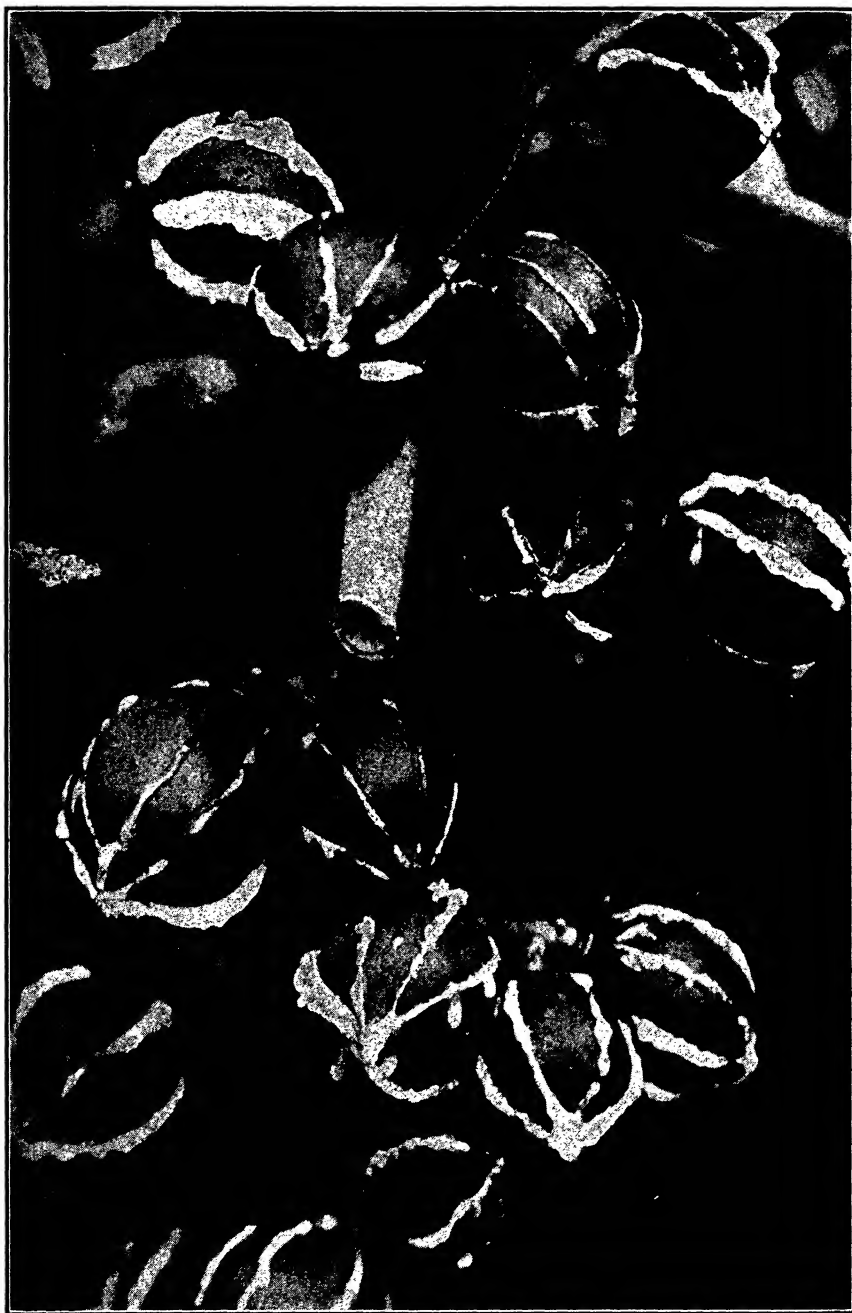


FIG. 288.—Portion of a tree of *Carica Papaya* showing incised fruits exuding latex.

creeping or climbing vine native to Jamaica. Commercial supplies of the authentic drug come only from Jamaica, and are usually preserved in alcohol. It contains mucilage, resin, a glycoside, tartaric acid, etc. While still in use by a few physicians in the treatment of neurogenic disturbance of cardiac

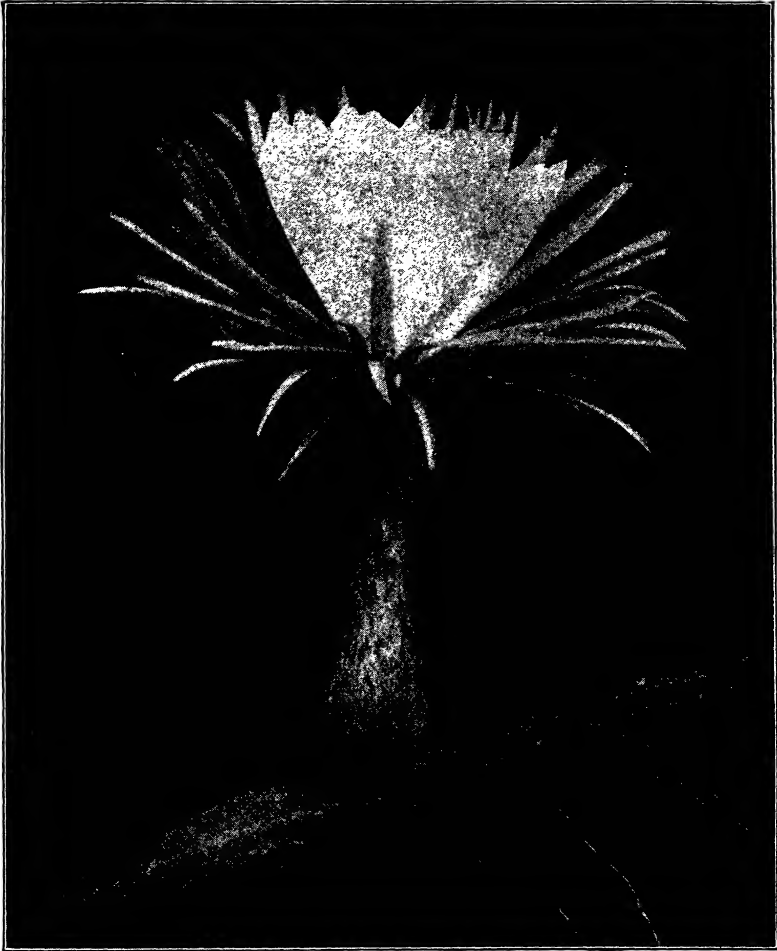


FIG. 289.—*Selenicereus grandiflorus* (L.) Britton & Rose (*Cactus grandiflorus*, Linnaeus.)  
(Portrait from United States National Museum through the kindness of Dr. J. N. Rose.)

rhythm, in neuresthenia and nicotinism, it is almost obsolete. For further details on this drug and its adulterants, see the fifth edition of this text, p. 591.

#### ANHALONIUM

**Synonyms.**—Peyote, Mescal-button, Mezcal-button, Devil's-root, *Lophophora*.

**Definition.**—The dried top of *Lophophora Williamsii* (Lem.) Coulter (*Anhalonium Williamsii* Lem.) (Fam. *Cactaceæ*).



**Habitat.**—Mexico and the Rio Grande region of the United States.

**Plant.**—A small, grayish-green, fleshy spineless cactus; a perennial herb whose subterranean axis gives rise to aerial shoots appearing somewhat like parsnips or peltate fungi. The disk or crown portion bears about 8 furrows and ridges, the latter broad and with tubercles. In the center or summit of the crown occur tufts of yellowish-white hairs among which pinkish flowers appear.

**Description.**—Mescal-buttons occur as dried brownish disks, representing transverse slices of the crown, from 1 to 1.5 inches in diameter and about  $\frac{1}{4}$  inch in thickness; when dry hard and brittle, upon moistening becoming soft; odor, upon moistening, peculiar and disagreeable; taste bitter.



FIG. 290.—The Peyote (*Lophophora Williamsii*).

**Constituents.**—The alkaloids *mescaline*, *pellotine*, *anhalonine*, *anhalonidine*, *lophophorine*, *anhalamine*, *anhalinine* and *anhalidine*, the number and relative proportions of which vary with the seasons and environment; two resins, wax, etc.

Mescaline ( $C_{11}H_{17}O_3N$ ) is stated to be the visual hallucination stimulating alkaloid. Pellotine ( $C_{15}H_{19}O_3N$ ) is a calmative. Anhalamine is an excitant and is stated to be identical with hordenine found in barley.

**Uses.**—Mescal-buttons are used by more than 30 tribes of American and Mexican Indians in a religious ceremony. From ten to forty disks are eaten by each participant. The first effect is cerebral excitement which is quickly followed by derangement of the sight center, causing a kaleidoscopic flow of colorful scenes of beauty, and later, dilatation of the pupil, and muscular

relaxation. An excessive dose has a tendency, sometimes, to cause unpleasant scenes. Peyote is also taken in the form of a decoction, in capsules of the powdered drug and in the form of the unofficial fluidextract for neurasthenia and hysteria.

*Mescaline sulfate* is used by psychopathologists to investigate mental derangements. *Anhalonine hydrochloride* and *Pellotine hydrochloride* are used occasionally in insomnia, neurasthenia and hysteria.

**Dose.**—Of Fluidextract, 0.6 to 0.9 cc. (10 to 15 minims); of the alkaloids or their salts, 21 to 65 mg. ( $\frac{1}{8}$  to 1 grain).

#### THYMELEACEÆ (MEZEREON FAMILY)

Shrubs (*Daphne Mezereum*) or low trees, usually of branching habit, the stems developing long tenacious bast fibers. Leaves alternate, rarely opposite, coriaceous, simple, varying from lanceolate to ovate, devoid of glandular hairs. The stem vascular bundles are bicollateral. Inflorescence a condensed raceme or spike. Flowers perfect, polygamous or diœcious, small, with calyx alone of the perianth parts developed. This is crimson-purple in *Daphne Mezereum*. Sepals usually fused to form a tube or cup-shaped perianth. Stamens usually eight in two rows of four longer and four shorter (*Daphne Mezereum*), inserted on the calyx tube. Pistil monocarpellary; ovary superior, mostly one-celled with a single pendulous ovule. Fruit a nut, drupe, or berry (*Daphne*). Calcium oxalate occurs in the form of rosette aggregates, styloids, micro-crystals or monoclinic prisms.

#### MEZEREUM N.F. (MEZEREUM)

**Synonyms.**—*Mezereon*, Mezereon Bark, Spurge Laurel, Wild Pepper; *Fr.* Écorce de Mézéréon; *Ger.* Seidelbastrinde, Kellerhalsrinde.

**Botanical Origin.**—*Daphne Mezereum* Linné, *Daphne Laureola* Linné and *Daphne Gnidium* Linné.

**Part Used.**—The dried bark.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter, it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—Europe and Asia.

**Plants.**—*Daphne Mezereum* is a straggling deciduous shrub with smooth, light gray bark, the young branches being covered with dense white hairs. Its leaves are alternate, lanceolate, entire and dark green, with very short petioles. Its small purplish-pink flowers appear in February in clusters of 2 or 3, sessile in the axils of fallen leaves, on branches of the previous year. Its fruit is an ovoid, slightly pointed, bright red drupe.

**Production and Commerce.**—The bark is collected from the shrubs from November to early March, dried and made up into rolls or small bundles. It enters commerce mainly through southern France, Algeria and Thuringia.

**Description.**—In flexible, tough, somewhat flattened strips or quilled pieces up to 90 cm. in length, of variable breadth and up to 1 mm. in thickness; outer surface yellowish or olive-brown (*D. Mezereum*) or dusky purple (*D.*

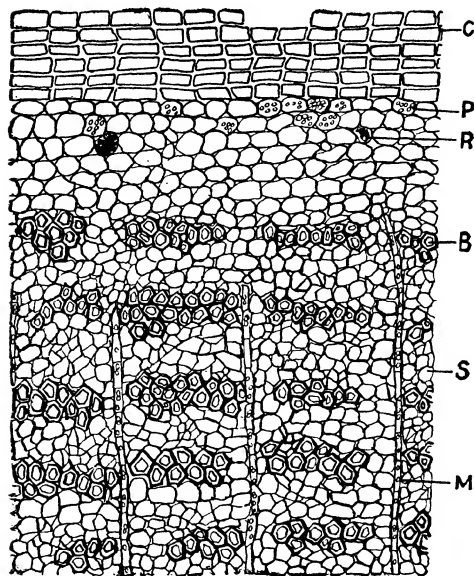


FIG. 291.—Mezereum. Transverse section of bark showing cork (C); collenchymatous tissue containing chloroplastids (P); cells containing greenish-yellow resinous substance (R); bast fibers (B); sieve tissue (S) and medullary-rays (M).

*Gnidium*) or purplish-gray (*D. Laureola*), smooth, showing numerous lenticels, and, occasionally, numerous, circular, dark colored apothecia of lichens; cork readily separable from the greenish yellow or yellowish brown middle bark; inner surface weak yellowish orange to pale yellow, satiny lustrous, finely striated; fracture tough, fibrous, the inner bark lamellated; odor faint; taste at first slight, becoming gradually and increasingly pungent and acrid.

**Histology.**—See Fig. 291.

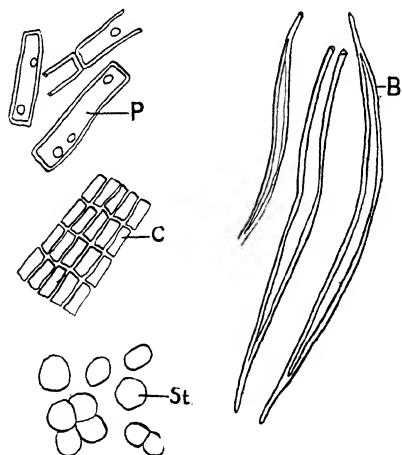


FIG. 292.—Powdered Mezereum. Parenchyma containing starch (P); cork tissue (C); starch grains (St); bast fibers (B).

nearly spheroidal to elliptical simple starch grains and occasional 2- to 4-compound starch grains, the individual grains from 3 to 15 $\mu$  in diameter.

**Powdered Drug.**—Yellowish gray to light yellowish brown; numerous long, non-lignified, poreless and colorless bast fibers that are often uneven or irregularly bent and considerably attenuated at their ends, their walls being from 1 to 5 microns in thickness; fragments of yellowish brown or colorless cork cells; fragments of starch-bearing medullary rays; fragments of cortical parenchyma containing resinous substance and chloroplasts; few

**Constituents.**—A greenish-brown acrid resin (*mezerein*) readily decomposing into mezereic acid in preparations of the bark, glucoside (daphnin), fixed oil, malic acid, sugars, starch, etc. Mezerein is the vesicant principle.

**Uses.**—Vesicant and counter-irritant.

**Average Dose.**—0.6 Gm. (10 grains).

#### LYTHRACEÆ (LOOSESTRIFE FAMILY)

Herbs (*Cuphea*), shrubs (*Lawsonia*) or low trees containing astringent principles. Leaves either alternate, opposite or whorled, simple, usually lanceolate to ovate, entire, often glandular, viscous and containing idioblasts. Stems and leaves possess bicollateral bundles. Inflorescence a raceme, spike, or condensed cyme. Flowers perfect, often dimorphic or trimorphic, usually regular, but pass more or less to irregular, sometimes very irregular as in genus *Cuphea*. Fruit a capsule, dehiscing longitudinally or transversely. Seeds exalbuminous. Calcium oxalate occurs in rosette aggregates and monoclinic prisms.

#### LAWSONIA (LAWSONIA)

**Synonyms.**—Henna, Henna Leaves, Alhenna, Egyptian Privet, Camphire.

**Botanical Origin.**—*Lawsonia inermis* Linné.

**Part Used.**—The dried leaves.

**Habitat.**—Probably Northern Africa and Western and Southern Asia.

**Plant.**—A shrub with spiny branches, opposite, lanceolate, entire, glabrous leaves, fragrant rose-colored flowers arranged in terminal panicles of cymes and capsular fruits. It has two varieties, var. *alba* Hassk. with white flowers and var. *miniata* with cinnabar-red blooms.

**Production and Commerce.**—Henna shrubs grow wild in Egypt, Arabia, Persia and India and are cultivated in the tropics and subtropics including India, Ceylon, the West Indies, Florida and California, but chiefly in Egypt. The commercial supply of the leaves comes largely from Egypt.

**Description.**—In entire or broken leaves with occasional stems and globular fruits. Leaves entire, brown to greenish brown to dull green, lanceolate, mucronate at apex, the margin entire and revolute, the base tapering, short petiolate, glabrous, coriaceous, up to 2 or 3 cm. in length and 1 to 2 cm. in width, odor upon crushing aromatic, tea-like; taste sweet, mucilaginous and slightly astringent. The fruits, when present, are thin, brown, globular capsules containing minute, brown, triangular and pitted seeds.

A decoction of the leaves is orange-brown, becoming deeper upon the addition of an alkaline solution.

**Histology.**—The leaf is bifacial in structure. Both upper and lower epidermis show epidermal cells with thick striated cuticle and numerous stomata. In cross section the epidermal cells appear tangentially-elongate to square (over the veins), in surface section somewhat polygonal with straight to slightly curvilinear vertical walls. The cuticle of upper epidermis is distinctly striated. Over the veins the cells are somewhat rectangular and show papillæ. Some of

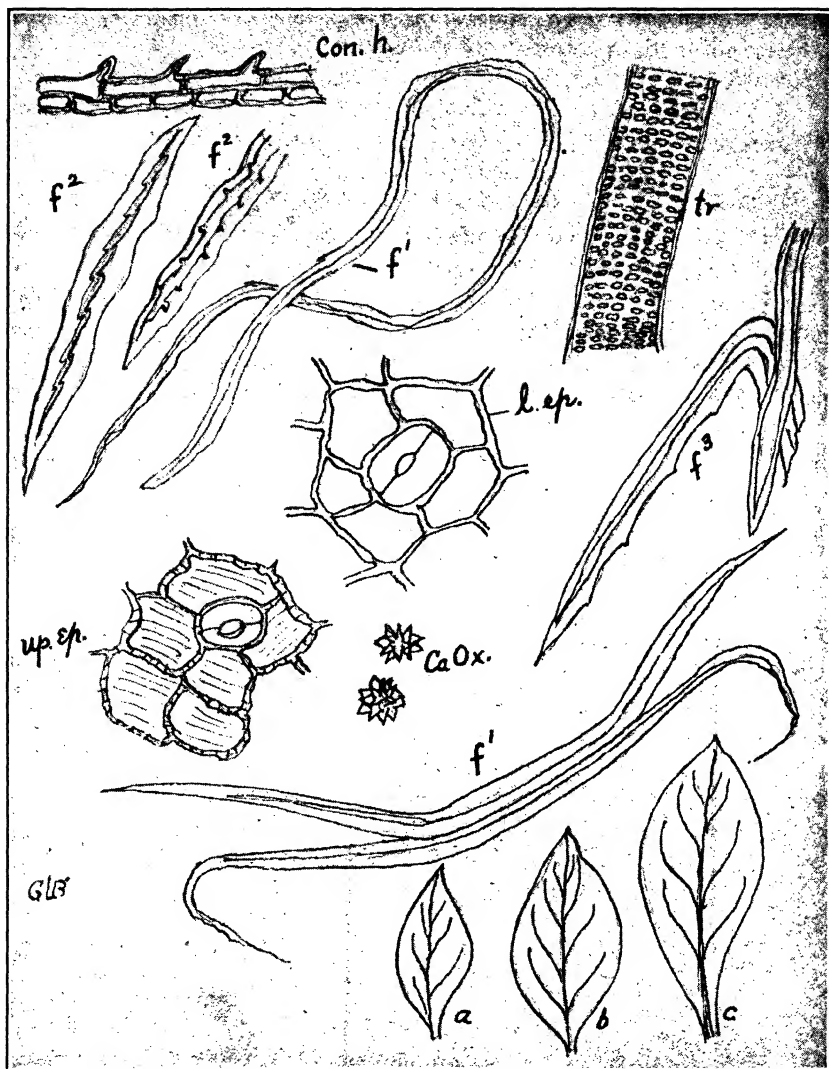


FIG. 293.—Henna. *a, b, c*, leaves; *f'*, very long, non-lignified, wavy-walled fibers with narrow lumina up to  $3000\mu$ ; *f²*, shorter fusiform fibers, up to  $240\mu$  long and up to  $24\mu$  in breadth, the walls  $8\mu$  thick; *con. h.*, portion of epidermis, in surface view, over a vein showing conical papillae; *up. ep.*, upper epidermis showing epidermal cells with beaded (porous) walls and striated cuticle, also a stoma; *l. ep.*, lower epidermis with a stoma; *f³*, a thick-walled fiber with pointed end and wavy-toothed wall; *Ca Ox.*, rosette aggregates of calcium oxalate; *tr*, pitted tracheae. (Drawing by G. L. Burroughs.)

the epidermal cells are specialized as mucilage sacs. These are spherical in shape and project into the subjacent palisade zone.

Beneath each epidermis is a region of several layers of palisade parenchyma and in the center a spongy parenchyma through which fibrovascular tissue with simple perforated tracheids courses. Scattered through the leaf parenchyma will be found occasional rosette aggregates and monoclinic prisms of calcium oxalate. Tracheæ with simple pores occur in the midrib.

A few papillæ or short non-glandular hairs occur on both epidermises. These are found over some of the veins.

In the midrib and stronger vein regions, the bundles are arranged in crescent fashion with narrow medullary rays separating them. Beneath the crescent of bundles is an interrupted to complete arc of sclerenchyma fibers, while collenchyma separates the bundle mass from each epidermis.

**Powdered Drug.**—Olive-green or brownish-green. Numerous fragments of cuticle and of leaf parenchyma, rosette aggregates and monoclinic prisms of calcium oxalate frequently up to  $25\mu$ , occasionally up to  $40\mu$  in diameter, globular mucilage cells, numerous fragments of fibrovascular tissue and of long, narrow, and shorter fusiform sclerenchyma fibers with thick walls, some of the latter being wavy-toothed, fragments of epidermis with stomata and striated cuticle, the stomata being surrounded by ordinary epidermal cells, occasional papillæ or non-glandular hair fragments.

**Constituents.**—An oxynaphthoquinone compound called *lawsone* ( $C_{10}H_6O_3$ ) which occurs in orange crystals, henna-tannic acid, mucilage, fat, resin, mannite, etc.

**Uses.**—Chiefly as a coloring agent for the hair, skin and nails.

**Adulterant.**—Leaves of *Coriaria myrtifolia*.

#### PUNICACEÆ (POMEGRANATE FAMILY)

A small family of shrubs and trees all of which are included in the single genus *Punica*. Leaves opposite to whorled, entire, glabrous and exstipulate. Flowers hermaphrodite, solitary or aggregate, terminal, calyx petaloid; corolla of 7 to 5 petals inserted to calyx throat; stamens numerous; in many series, inserted below the petals; ovary inferior and imbedded in upgrown receptacle, its upper portion 7 to 5 celled with parietal placentation, its lower portion 3 celled with central placentation; style filiform; stigma capitate; ovules numerous, anatropous. Fruit a spherical, baccate capsule crowned by the persistent calyx, its locules separated by membranous septa. Seeds numerous, exalbuminous.

#### GRANATUM (POMEGRANATE)

**Synonyms.**—Pomegranate Bark, Carthaginian Apple, Grenadier; *Ger.* Granatrinde; *Fr.* Écorce de Balaustier.

**Botanical Origin.**—*Punica Granatum* Linné.

**Part Used.**—The dried bark of the stem or root.



FIG. 294.—A fruiting tree of *Punica Granatum*, the Pomegranate. (Photograph by Stuhr; courtesy of B. V. Christensen.)

**Limit of Impurities.**—2 per cent. of wood or other foreign organic matter (U.S.P. X).

**Habitat.**—India.

**Plant.**—A large shrub or small tree with oblong or obovate, shining leaves, orange-red showy flowers and large, red, many seeded, pome-like, berry fruits, the seeds of which are surrounded by a succulent, red, edible flesh.

**Description.** *Stem Bark.*—This occurs in transversely curved pieces or quills of variable length and up to 3.5 mm. in thickness; outer surface yellowish to grayish-brown with grayish patches of foliaceous lichens with their brownish-black apothecia, longitudinally wrinkled, also marked with small, broadly elliptical lenticels and with more or less abraded patches of cork; inner surface light yellow or yellowish-brown, finely striate; fracture short, smooth, exhibiting a greenish phelloderm; odor slight; taste astringent, somewhat bitter and nauseous.

*Root Bark.*—In transversely curved pieces; externally brownish-yellow to dark brown with irregular scaly patches of cork; internally dark yellow, the green phelloderm region, so characteristic of the stem bark, being absent.

**Histology.**—Transverse sections of the *stem bark*, when examined microscopically, display the following structural characteristics.

1. *Cork* of several layers of more or less tabular cells and composed of alternating rows of thin-walled suberized cells and lignified cells with greatly thickened inner walls.

2. *Cork cambium* of meristematic cells.

3. *Phelloderm* of several rows of cells containing chloroplastids, tannin and starch grains.

4. *Primary cortex* of several rows of parenchyma cells with starchy, or calcium oxalate contents. In this region there also occur large, thick walled and lamelated stone cells with branching pore canals. These are arranged singly or in small groups. Calcium oxalate crystals occur in various cells of the primary cortex both as rhombohedral crystals and rosette aggregates.

5. *Phloem*, a broad region of numerous narrow phloem patches separated by medullary rays most of which are one cell in width. Each phloem patch is characterized by its numerous tangential rows of cells containing rosette aggregates of calcium oxalate. Other phloem cells possess starch grains, still others contain yellowish-brown amorphous tannin masses. Bast fibers are absent.

The *root bark*, as seen in cross section, somewhat resembles the stem bark, differing mainly from the latter by the absence of primary cortex, chloroplastids, and, the presence of a broader phloem, the medullary rays of which extend nearly to the outer surface.

**Powdered Drug.**—Yellowish-brown to dark brown; calcium oxalate crystals numerous, in rosette aggregates, rhombohedra, or crystal fibers, the individual crystals up to  $18\mu$  in diameter; fragments of cork with lignified walls; starch grains numerous, spheroidal, ellipsoidal or irregular, simple or compound, the simple grains up to  $12\mu$  in diameter; stone cells mostly single, occasionally in



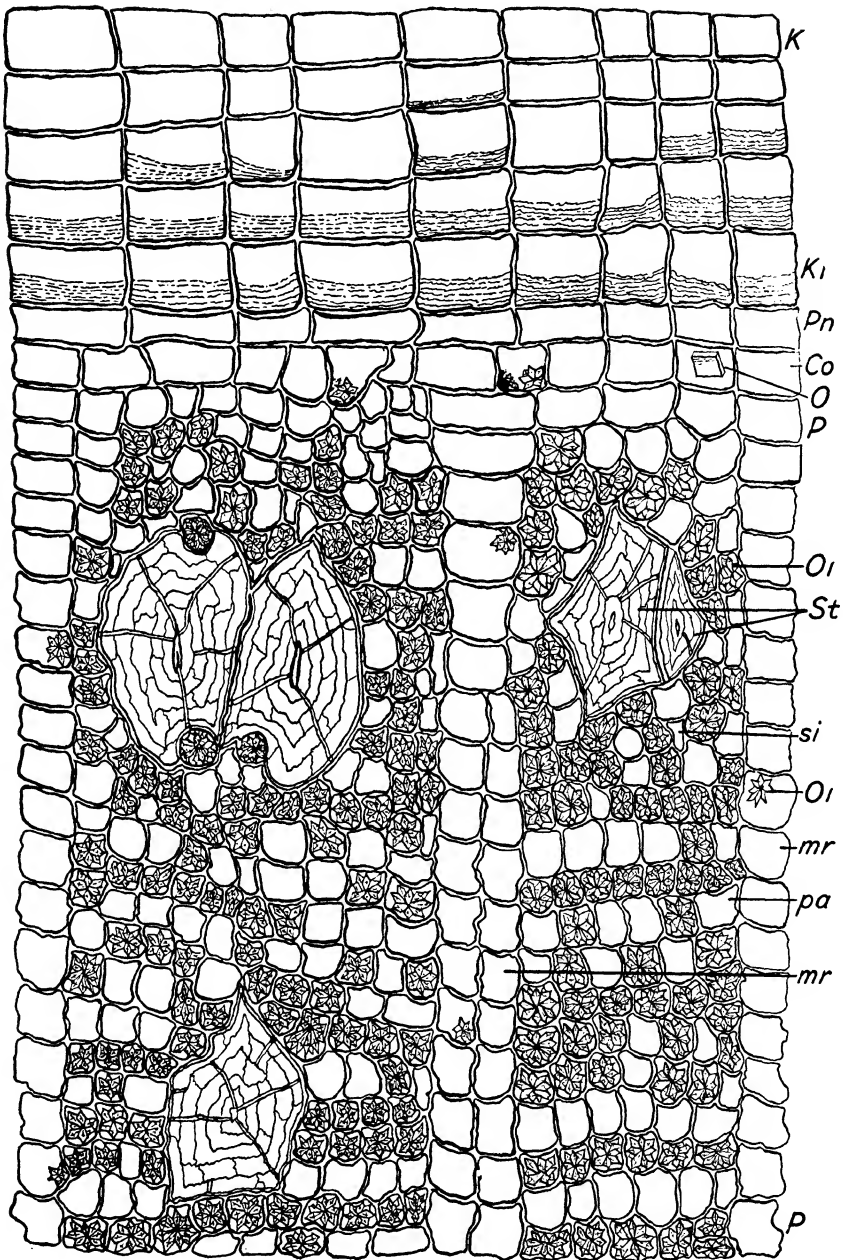


FIG. 295.—Pomegranate Bark. Transverse section,  $\times 46$ . K, nonlignified, thin-walled cork cells; Ki, cork cells with thickened, lignified, inner walls; Pn, phellogen; Co, cortex; O, rhombohedral crystal of calcium oxalate; P-P, phloem; O<sub>1</sub>, rosette aggregate crystals of calcium oxalate; St, stone cells; si, sieve tube; mr, medullary ray; pa, phloem parenchyma. (Drawing by E. W. Heaps.)

small groups, the individual cells from 50 to 300 $\mu$  in length and possessing thick, strikingly lamellated walls with branching pore canals; fragments of parenchyma containing yellowish-brown amorphous masses or chloroplastids. The latter are not present in ground or powdered root bark. Samples of powdered drug

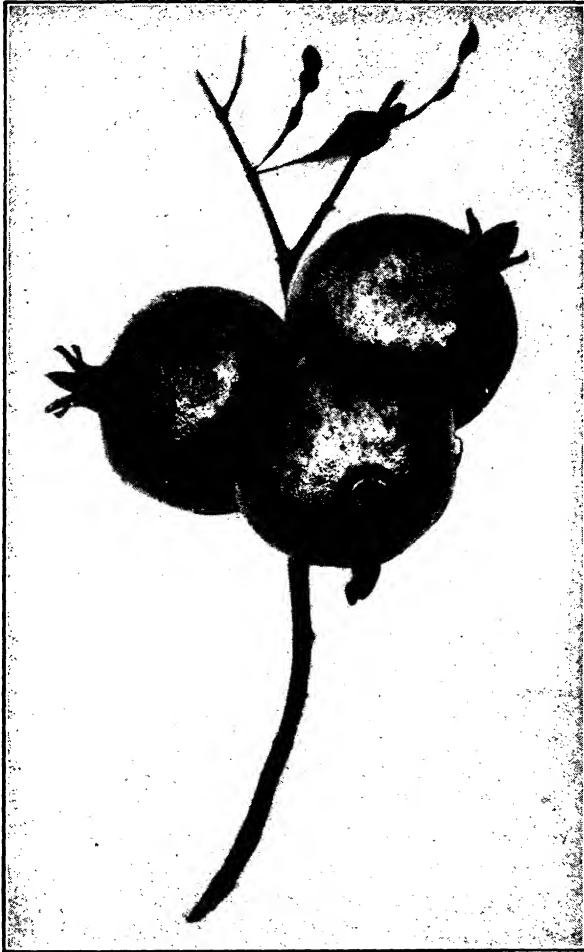


FIG. 296.—Fruiting branch of *Punica Granatum* Linné. The rind of the fruit known as Pomegranate rind contains about 28 per cent. of tannin and is used as an astringent.

obtained from bark to which wood adhered show occasional slightly lignified wood fibers and porous tracheæ.

**Constituents.**—The liquid alkaloids, *pelletierine*, *methylpelletierine*, *methylisopelletierine*, *isopelletierine*; the solid crystalline alkaloid, *pseudopelletierine*; about 22 per cent. of *tannin*; starch, calcium oxalate and a yellow coloring substance. The tannin gives a bluish black precipitate with iron solutions.

**Uses.**—Pomegranate bark is used as a *tœniacuge* usually in the form of a decoction and for the preparation of Pelletierine Tannate.

**Average Dose.**—2 Gm. (30 grains).

**Adulterants.**—(1) Bark of *Buxus sempervirens* or Boxwood. (2) Bark of *Berberis vulgaris* or Barberry. Both of these are devoid of tannin.

**Pelletierinæ Tannas** N.F. (Pelletierine Tannate) represents a mixture in varying proportions of the tannates of the several alkaloids obtained from pomegranate bark, *Punica Granatum* L. (Fam. *Punicacæ*). It is a light yellow, odorless, amorphous powder, with an astringent taste. It should be kept in tight, light-resistant containers. Tæniafuge. Average dose, 0.25 Gm. (4 grains).

### MYRTACEÆ (MYRTLE FAMILY)

Rarely herbs (*Careya*) mostly shrubs or trees with schizogenous secretory cavities containing aromatic volatile oils, some being the tallest trees known (*Eucalyptus*). Stems often tend to develop cork in flakes which separate much as in the Buttonwoods. Leaves rarely alternate, nearly always opposite, entire, often glistening, subcoriaceous to coriaceous (*Eucalyptus*, *Pimenta*, etc.), frequently edge-on in position upon branches. The stomates are frequently devoid of special neighbor cells but in the genus *Myrcia* have two such cells parallel to the pore. Intraxylar phloem occurs in the stems, leaves and receptacle of flowers. The wood prosenchyma possesses bordered pores. Inflorescence cymose, at times forming scorpioid cymes, becoming condensed into small fascicles, or each cyme condensing into a solitary flower.

Flowers regular or very rarely irregular from the lop-sided development of the stamens. Symmetry rarely hexamerous, typically pentamerous, not infrequently reduced to tetramerous (*Clove*); sepals five, six or four, aposepalous, synsepalous at base, superior and inserted around the edge of an expanded, upgrown receptacular disc, varying from green and more or less expanded to short, thick, fleshy (*Clove*) or reduced to teeth (*Eucalyptus*); petals equal in number to the sepals, more or less petaloid and enlarged, rarely reduced and wanting, varying in color from green through greenish yellow to white (*Eugenia* species) or from whitish to pink, scarlet, crimson, purple and blue, petals sometimes synpetalous and cup-like, detaching as the flower opens; stamens usually indefinite and epigynous, varying in the color of their filaments as do the petals; pistil rarely of ten to six carpels, usually of five, not infrequently as in *Clove* of four carpels; ovary inferior or semi-inferior, as many-celled as there are carpels and with central placentation; style elongate; stigma undivided. Fruit either a hard, woody indehiscent nut (Brazil Nut), a capsule dehiscing at apex (*Eucalyptus*) or berry (*Eugenia*). Seeds exalbuminous. Rutin occurs in the leaves of some species of *Eucalyptus*.

### EUCALYPTUS (EUCALYPTUS)

**Synonyms.**—Blue Gum Leaves, Australian Fever Tree Leaves, Iron Bark Tree; *Fr.* Feuilles d'Eucalyptus; *Ger.* Eucalyptus Blätter.

**Botanical Origin.**—*Eucalyptus globulus* Labillardière.

**Part Used.**—The dried scythe-shaped leaf.

**Limit of Impurities.**—3 per cent. of stems, fruits or other foreign organic matter (U.S.P. X).

**Habitat.**—Australia and Tasmania. Cultivated in California and Southern Europe.

**Plant.**—A very tall tree with ash-gray bark, opposite leaves on younger branches and alternate leaves on older ones, and white flowers, the calyx

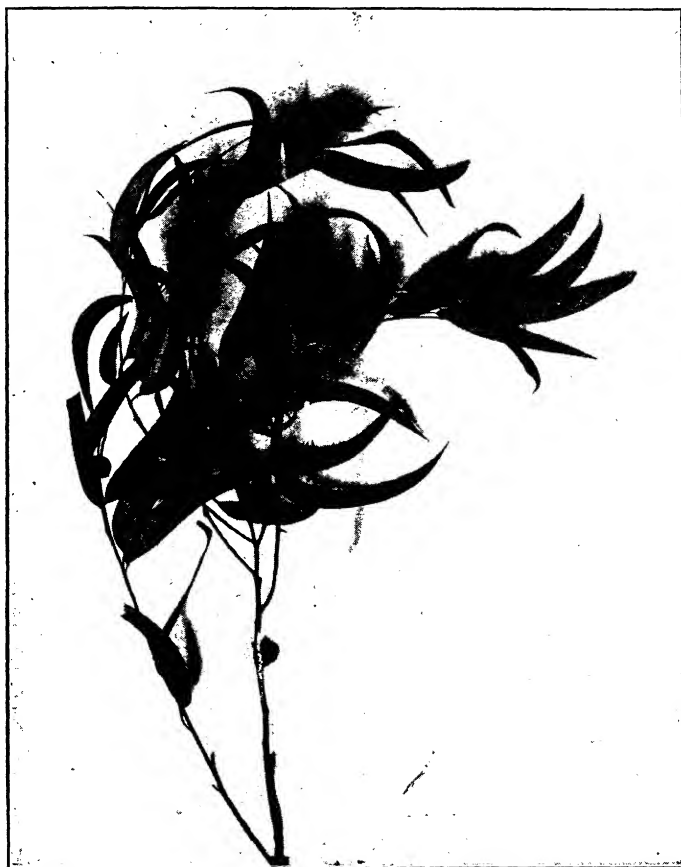


FIG. 297.—Leafy branch of *Eucalyptus globulus*,  $\times \frac{1}{4}$ . (Photograph by Stoneback.)

tube of each of which is covered by a conical lid called the operculum, and composed of the limb of the calyx and united petals. The fruit is a woody truncated capsule.

**Production and Commerce.**—The Eucalyptus trees are grown in Australia, Tasmania, Southern Europe and California and are amongst the tallest trees known. The leaves are gathered from older parts of the trees, dried and baled. The commercial supplies are mainly shipped to the U. S. A. from Brussels, Antwerp and Marseilles. Eucalyptus oil is imported chiefly from Australia, Spain, Uruguay, Brazil, French Oceania and Guatemala.

**Description.**—Petiole twisted; lamina lanceolately scythe-shaped, bifacial, from 8 to 30 cm. in length and from 2 to 7 cm. in breadth; coriaceous; apex, when present, acute or acuminate; base unequal, obtuse or somewhat rounded; margin uneven, revolute; ventral and dorsal surfaces grayish-green to pale yellowish-green, more or less glaucous, glabrous, glandular-punctate, with numerous small, rounded, brown dots of cork; venation pinnate-reticulate, the veins of the first order running to within a short distance from the margin where they anastomose with each other and form a vein nearly parallel with the margin; odor aromatic; taste aromatic, bitter and cooling.

**Histology.**—1. **Upper and lower epidermis** composed of clear, polygonal epidermal cells with thick cutinized outer walls. Both epidermises possess sunken stomata.

2. **Mesophyll** (chlorenchyma) differentiated into palisade and spongy parenchyma regions, there being two palisade regions of 3 to usually 4 rows of cells each, one facing each epidermis. In each of these regions occur large, sub-globular, internal glands, lined with secretory epithelium and containing yellow oil of Eucalyptus. The spongy parenchyma region is a narrow zone of more or less loosely arranged cells between the 2 palisade zones. Some of its cells contain rosette aggregates while others possess monoclinic prisms of calcium oxalate. Fibrovascular tissue courses through the spongy parenchyma. In the midrib and petiole a more or less interrupted arc of slightly lignified pericyclic fibers occurs just outside these bundles.

**Powdered Drug.**—Light green; fragments of chlorenchyma with embedded, broken, yellow, internal glands numerous; calcium oxalate in rosette aggregates or monoclinic prisms up to  $25\mu$  in diameter; fragments of epidermis with polygonal cells having very thick cuticle and sunken, almost invisible stomata; fragments of sclerenchyma fibers and thick walled stone cells; fragments of cork; tracheids.

**Constituents.**—Up to 6 per cent. of a colorless or pale yellow *volatile oil* having an aromatic, camphoraceous odor and a pungent, spicy, cooling taste (U.S.P.) of which 70 per cent. or more is *eucalyptol* (U.S.P.), the balance consisting of d-pinene and other terpenes; resins, *a bitter principle*, tannin, eucalyptic acid, calcium oxalate.

**Uses.**—Stomachic, carminative, expectorant, rubefacient, antiseptic and antiperiodic.

**Average Dose** (unof.).—2 Gm. (30 grains).

**Adulterants.**—(1) Leaves from young branches of *E. Globulus* that are ovate-oblong, dorsoventral and opposite. These show stomata only on the dorsal surface and palisade parenchyma only beneath the ventral epidermis. (2) Leaves of allied species, some of which are less leathery in texture and not as fragrant in odor.

**Eucalyptus Oil** (Oleum Eucalypti) U.S.P. represents the volatile oil distilled with steam from the fresh leaves of *Eucalyptus Globulus* or from some other species of *Eucalyptus* (Fam. *Myrtaceæ*). It is colorless to pale yellow with a characteristic, aromatic, camphoraceous odor and a pungent, spicy, cooling

taste, sp. gr. 0.905 to 0.925; congealing temp. not lower than  $-15.4^{\circ}\text{C}.$ ; ref. ind. 1.4580 to 1.4700 at  $20^{\circ}\text{C}.$  It contains not less than 70 per cent. of eucalyptol (cineol). Stimulant, antiseptic. Average dose, 0.5 cc. (8 minims).

**Eucalyptol U.S.P.** or Cineol is a substance  $[\text{C}_{10}\text{H}_{18}\text{O}]$  obtained from oil of Eucalyptus and from other sources. Stimulating expectorant; antiseptic in nose and throat inflammations. Average dose, 0.3 cc. (5 minims). It enters into Aromatic Spray and Compound Menthol Spray N.F.

#### EUCALYPTUS GUM (EUCALYPTI GUMMI)

**Synonyms.**—Red Gum, Australian Kino, Eucalyptus Kino, Creek Gum.

**Botanical Origin.**—*Eucalyptus camaldulensis* Dennhardt (*Eucalyptus rostrata* Schlechtendal) and other species of *Eucalyptus*.

**Plants.**—*Eucalyptus camaldulensis* Dennhardt or Red Gum is a forest tree attaining a height of 200 feet with gray bark and reddish twigs. It possesses lanceolate, acuminate leaves, axillary umbels of small flowers, each with a hemispheric calyx tube and lid, the latter beaked, and small, nearly globular, capsular fruits. Other Australian trees yielding smaller amounts of this drug include *E. amygdalina*, *E. marginata*, *E. falcifolia*, *E. Leucoxylon*, *E. Gunni*, *E. piperita*, *E. macroryncha*, and *E. stellulata*.

**Part Used.**—The dried gummy exudate.

**Habitat.**—Australia.

**Production and Commerce.**—A red juice is secreted in cavities of the wood or between the bark and wood, of these trees. It is obtained by making an incision into the trunk and inserting a trough-shaped piece of tin, by means of which the liquid, as it exudes, is conveyed into buckets. The juice is then boiled or allowed to evaporate spontaneously until it attains the consistency of a solid mass. This becomes friable, breaking up into fragments. The commercial supplies are shipped from Melbourne and Victoria, Australia to England, thence some reach this country.

**Description.**—When first collected the juice has a syrupy consistency and a sour odor. After drying it occurs in friable masses of a blackish color or in grains; small fragments are ruby-red, have a dusty appearance, and lack the brittleness of those of Malabar Kino; odor indistinct; taste astringent, imparting a red color to the saliva. From 80 to 90 per cent. of the drug is soluble in cold water.

**Constituents.**—46 to 47 per cent. of *kino-tannic acid*; kinoin, kino red catechin and pyrocatechin.

**Use.**—Astringent in pharyngitis and laryngitis, in the form of troches, usually called "Red Gum Lozenges."

**Average Dose.**—0.6 Gm. (10 grains).

#### OIL OF CAJUPUT (OLEUM CAJUPUTI)

**Synonyms.**—Cajuput Oil, Oil of Cajeput; *Ger.* Cajeput Öl; *Fr.* Essence de Cajeput.



FIG. 298.—*Melaleuca Leucadendron*, the chief source of oil of cajuput.

**Botanical Origin.**—Several varieties of *Malaleuca Leucadendron* Linné and other species of *Melaleuca*.

**Part Used.**—The volatile oil distilled from the fresh leaves and twigs, rectified by steam distillation.

**Habitat.**—Australia, New South Wales, East Indies, Islands of Indian Ocean.

**Plants.**—Evergreen trees with pale buff, spongy bark, elliptic or oblong leaves, axillary spikes of creamy white flowers, becoming pink to purple in Australia, and capsular fruits.

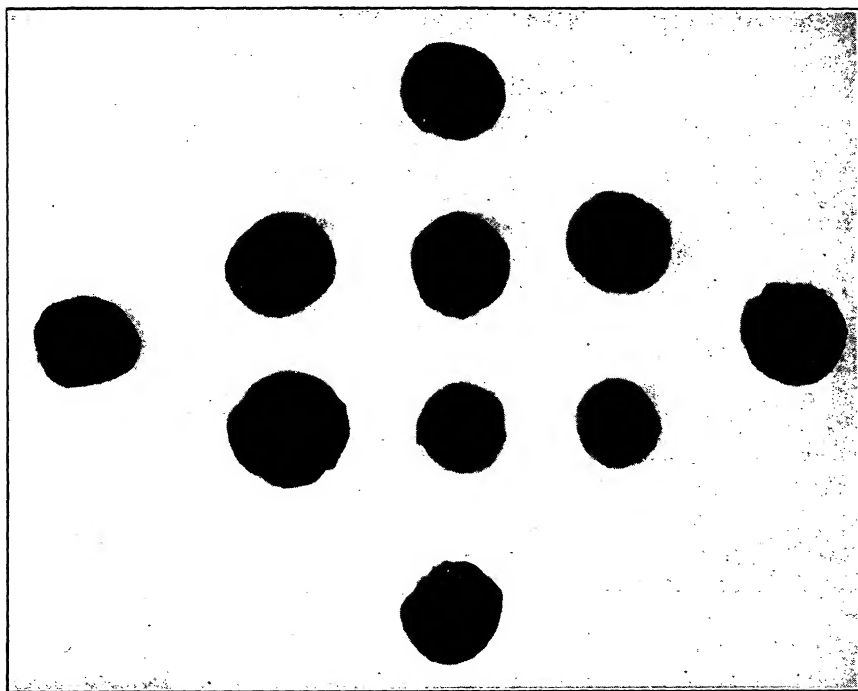


FIG. 299.—Allspice,  $\times 1\frac{1}{4}$ . (Photograph by Stoneback.)

**Production and Commerce.**—The volatile oil is distilled from the fresh leaves and twigs chiefly in Amboyna, Banda, and Bourou. It is exported in wine bottles or drums from the East Indies. The green color of some specimens of cajuput oil is claimed to be due to a copper salt obtained from some vessels in which the distillation is performed but it may be also ascribed in some instances to copper added for the purpose of maintaining the fine green color of the oil used by a portion of the trade. The crude or unrectified oil is green or bluish green. The U.S.P. X permitted only the yellowish or colorless oil.

**Description.**—A colorless or yellowish, green or bluish-green liquid having a peculiar, agreeable camphoraceous odor and an aromatic, slightly bitter taste.



**Constituents.**—*Cajuputol* which is identical with eucalyptol and cineol (50 to 60 per cent.); a terpineol present in free state and as the acetic ester, *l*-pinene and traces of valeraldehyde and benzaldehyde.

**Uses.**—Stimulating expectorant, urinary antiseptic, anthelmintic; internally as a counterirritant in rheumatism, etc. and as a parasiticide in various skin diseases.

**Average Dose.**—0.5 cc. (8 minims).

#### PIMENTA (PIMENTA)

**Synonyms.**—Allspice, Pimento, Jamaica Pepper, Clove Pepper; *Fr.* Toute épice; *Ger.* Nelkenpfeffer, Allerlei-Gewürz.

**Botanical Origin.**—*Pimenta officinalis* Lindley.

**Part Used.**—The dried, nearly ripe fruit.

**Purity Rubric.**—Not less than 8 per cent. of quercitannic acid (calculated from the total oxygen absorbed by the aqueous extract), not more than 25 per cent. of crude fiber, not more than 6 per cent. of total ash and not more than 0.4 per cent. of acid-insoluble ash (S. R. A., F. D. A., U. S. Dep. Agr., Rev. 5, 1936).

**Habitat.**—West Indies, Mexico, Central America and Northern South America.

**Plant.**—An evergreen tree growing to the height of about 12 m. Its leaves are entire, ovate-oblong, pellucid-punctate on dorsal surface. Its flowers are small, white and borne in racemose cymes. Its fruit is a berry crowned with a persistent calyx and style.

**Production and Commerce.**—The fruits are gathered when full grown but green, by breaking off the inflorescence axes and drying the twigs and berries in ovens or rarely in the sun. The dried fruits are readily separated. The commercial supplies are imported from Jamaica, Guatemala, Honduras and Mexico.

**Description.**—A mixture of entire berries and broken stems. Berry inferior, sub-globular to globular, dark brown to dark reddish-brown, the surface being round and granular; summit with calyx ring, within which is a depression containing the remains of the style; base with short stalk or stem scar; internally exhibiting 2 or 3 chambers, separated by thin dissepiments, each chamber containing a single plano-convex to angular reddish-brown seed; odor aromatic; taste sweet and pungent. Sections of allspice exhibit numerous oil glands and stone cells in the mesocarp.

**Powdered Drug.**—Reddish-brown or dark brown. Numerous stone cells of variable shape with porous, strongly lignified walls and frequently containing a brownish amorphous substance; numerous simple or 2-3 compound starch grains, the individual grains spherical, plano-convex or polygonal with a central hilum and averagely up to 25 $\mu$  in diameter; fragments of irregular shape containing internal glands with a yellowish-brown oil content; rosette crystals of calcium oxalate; few stem fragments showing somewhat curved, narrow lumened, 1-celled, non-glandular hairs, long, narrow sclerenchyma fibers and tracheids.

**Constituents.**—*Volatile oil* (3 to 4 per cent.) containing *eugenol* (U.S.P.), *cineol*, *caryophyllene* and *l-phellandrene*, an *acid fixed oil*, *tannin*, *resin*, etc.

**Adulterants of Powder.**—Ground olive pits, coconut shells, cocoa shells, allspice stems, etc.

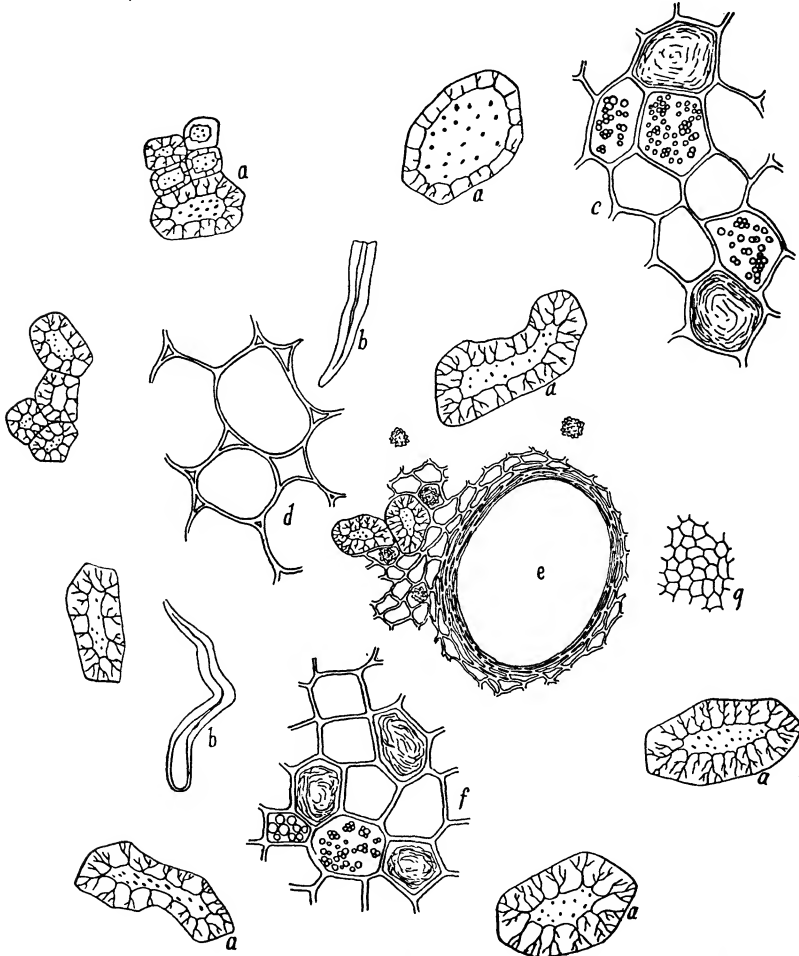


FIG. 300.—Powdered *Pimenta*. (a) Stone cells; (b) trichomes; (c) parenchyma with starch and resin; (d) parenchyma; (e) gland, stone cells and crystal bearing cells; (f) endosperm cells with starch and resin; (g) epidermal cells. (Schneider.)

**Uses.**—Aromatic and condiment. As a condiment it is extensively employed in flavoring meats, relishes, preserves, and is an important ingredient in whole mixed pickling spice, and many ground spice formulas such as poultry dressing, curry powder, mincemeat spice, pork sausage, frankfurter and bologna seasonings.

**Average Dose.**—1 Gm. (15 grains).

**Pimenta Oil** (*Oleum Pimentæ*) N.F. or *Allspice Oil* is a volatile oil distilled from the fruit of *Pimenta officinalis* (Fam. *Myrtaceæ*) yielding not less than

65 per cent., by volume, of phenols. It is a colorless, yellow or reddish yellow liquid becoming darker with age; sp. gr. 1.018 to 1.048 at 25°C., opt. rot. 0° to -4°; ref. ind. 1.5270 to 1.5400 at 20°C. It is a stimulant, antiseptic and flavoring agent. Average dose, 0.1 cc. (1½ minims).

**Preparation.**—Compound Myrcia Spirit, N.F.

**Myrcia Oil (Oleum Myrciæ) N.F.** or *Bay Oil* is a volatile oil distilled from the leaves of *Pimenta racemosa* (Miller) J. W. Moore [*Pimenta acris* (Swartz) Kostel] (Fam. *Myrtaceæ*), a tree indigenous to the West Indies. It yields not less than 50 per cent. and not more than 65 per cent., by volume, of phenols. It is a yellow or brownish yellow liquid with an agreeable aromatic odor and a spicy, pungent taste; sp. gr. 0.950 to 0.990 at 25°C.; opt. rot. -3 at 25°C.; ref. ind. 1.5070 to 1.5160 at 20°C.

Bay Oil is produced chiefly in Dominica and Puerto Rico and to a lesser extent in St. Lucia, Montserrat and the Virgin Islands. It contains *eugenol*, *methylchavicol*, cineol, aldehydes, *a*-phellandrene, etc. It is used in the preparation of Compound Spirit of Myrcia (bay rum), in toilet waters and perfumes, in the scenting of soaps, etc.

#### CLOVE U.S.P. (CARYOPHYLLUS)

**Synonyms.**—*Cloves*; *Fr.* Girofle, Clous aromatiques; *Ger.* Gewürznelken, Nägelein.

**Botanical Origin.**—*Eugenia caryophyllata* Thunberg (*Caryophyllus aromaticus* L.).

**Part Used.**—The dried flower-bud.

**Purity Rubric.**—Not more than 5 per cent. of its stems and not more than 1 per cent. of other foreign organic matter. Clove yields, from each 100 Gm., not less than 16 cc. of oil of clove. It yields not more than 10 per cent. of crude fiber and not more than 0.75 per cent. of acid-insoluble ash.

**Ash.**—Not more than 7 per cent. total ash nor more than 0.5 per cent. of ash insoluble in hydrochloric acid (S. R. A., F. D. A., U.S. Dep. Agr., Rev. 5, 1936).

**Habitat.**—Molucca Islands.

**Plant.**—An evergreen tree attaining a height of 30 or 40 feet. The leaves are entire, smooth, coriaceous and glandular punctate. The flowers are tetramerous, rose-colored and arranged in axillary and terminal racemes of cymes. The fruit is an ovoid berry which, when nearly ripe, is collected and sold as "Mother of Cloves."

**Production and Commerce.**—The clove trees are cultivated in Java, Ceylon, Zanzibar, Pemba and Madagascar. The flower buds are gathered when pink and unexpanded (generally in August or September) by natives, who climb the trees and gather the bunches of unopened buds attached to the branched flower cluster axis and later strip the buds from the branched axis, the latter representing the "clove stems." They are then either dried in the sun or artificially on cement drying floors, garbled, and packed in bales.

The commercial supplies come mainly from British East Africa, Zanzibar, Madagascar, the Dutch East Indies, especially Amboyna and Penang, and

British Malaya. The finest cloves come from Penang. They are large, plump and reddish-brown.

**Description.**—From 10 to 17.5 mm. in length, of a dark brown or dusky red color, consisting of a sub-cylindrical, slightly flattened, 4-sided hypanthium (stem-like receptacle) containing in its upper portion an inferior, 2-celled ovary with numerous ovules attached to a central placenta; receptacle terminated by

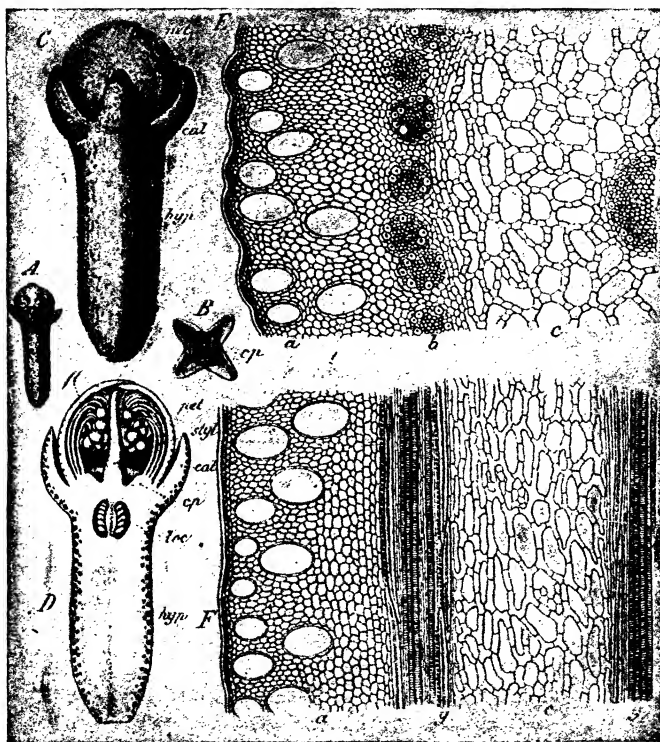


FIG. 301.—Clove. A, Whole clove (nat. size). B, The same viewed from above without corolla, stamens or style. C, A clove (enlarged). D, The same viewed in longitudinal section. E, Representative portion of a transverse section cut through the receptacle of clove,  $\times 50$ . F, Representative portion of a longitudinal section of clove cut through receptacle,  $\times 50$ . cal, calyx; pet, corolla; cp, carpels; hyp, receptacle; st, stamens; styl, style; loc, locule of ovary; a, parenchyma of receptacle containing oil glands (l); b and y, fibrovascular bundles containing sclerenchyma fibers; c, pith. (After Berg.)

an epigynous calyx of four thick, divergent sepals and surmounted by a nearly globular head, consisting of four membranous, imbricated petals, which enclose numerous curved stamens and one style; odor strongly aromatic; taste pungent and aromatic, followed by a slight numbness of the tongue.

When Clove is pressed strongly between the thumb nail and finger the volatile oil becomes visible.

Stems (representing pedicels, rachis and peduncle of clove inflorescence) either separate or attached to the flower-buds; sub-cylindrical or four-angled, attaining a length of 25 mm. and a diameter of 4 mm., either simple, branching or distinctly jointed, and less aromatic than the flower-buds.

**Histology.**—Transverse sections of clove hypanthium (receptacle) cut below the ovary show the following structures:

1. *Epidermis* of small epidermal cells with a thick cuticle and scattered stomata.

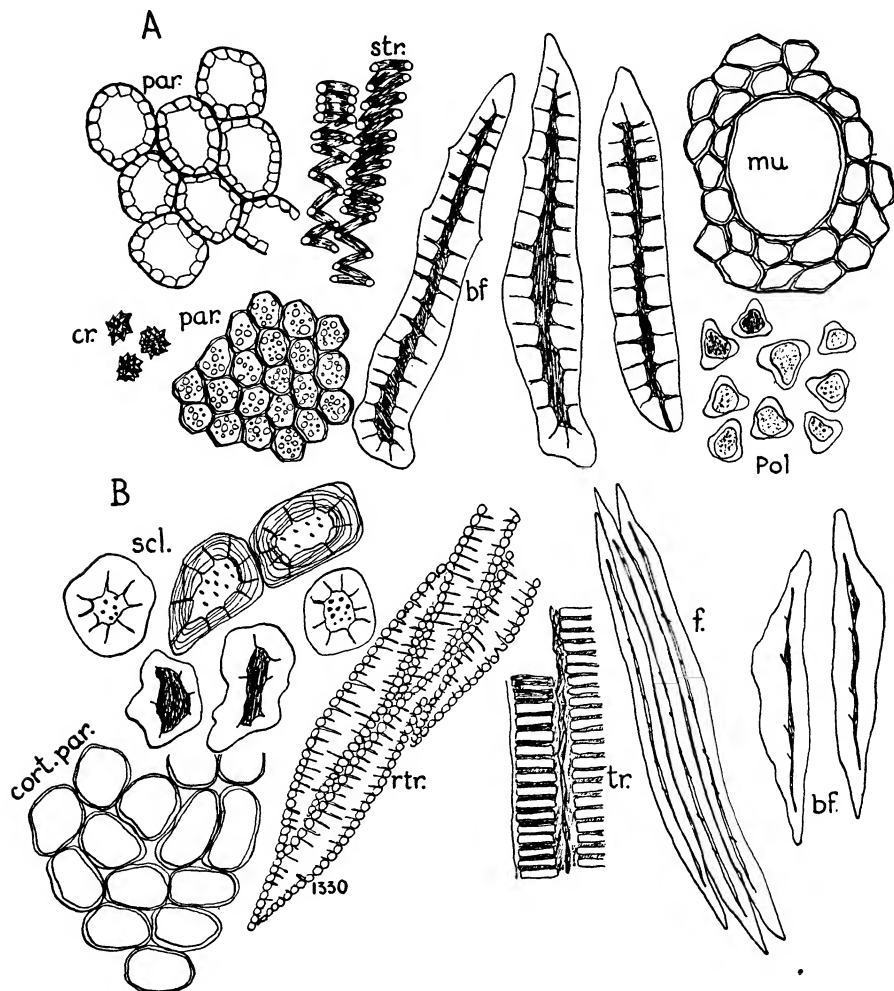


FIG. 302.—A, Powdered Clove. B, Powdered Clove Stem (inflorescence axis). *par*, parenchyma; *cr*, rosette aggregates of calcium oxalate; *st*, thickenings of spiral tracheae; *bf*, bast fibers; *mu*, secretion reservoir imbedded in cortical parenchyma; *pol*, pollen grains; *scl*, stone cells; *cort. par.*, cortical parenchyma; *rtr*, reticulate tracheids; *tr*, scalariform tracheae; *f*, fibers from inner face of bundles; *bf*, fibers from outer face of bundles.

2. *Cortex* of several zones. The outermost zone contains 2 or 3 rows of large ovoid to elliptical-shaped oil-reservoirs up to about  $200\mu$  in length which are lined by secretory epithelium. The reservoirs are imbedded in moderately thick-walled parenchyma. Beneath this will be noted the bundle zone consisting of an interrupted circle of small bicollateral fibrovascular bundles accompanied by

a few thick-walled sclerenchyma fibers and by crystal-fibers containing rosette aggregates of calcium oxalate. The bundles are imbedded in parenchyma whose cells possess wavy walls. Beneath the outer bundle zone occurs a zone of parenchyma some of the cells of which possess thickened angles and wavy walls; others form chains around intercellular-air-spaces. Next, a zone of normal, small-celled parenchyma which is followed by a second or inner zone of fibro-vascular bundles.

3. *Inner zone of fibrovascular bundles* of bicollateral type composed of smaller elements than those of the outer bundle zone, the bundles being closely adjacent and usually showing fewer accompanying fibers.

4. *Pith*, a central zone of ordinary parenchyma, some of its cells containing rosette aggregate crystals of calcium oxalate.

Transverse sections cut through the upper region of the hypanthium which lodges the imbedded ovary resemble in their outer regions the sections cut below the ovary, the important differences being the presence of an increased number of outer bundles and the central region which shows a 2-locular ovary with central placenta bearing ovules. The dissepiment which bisects the ovary lodges the inner zone of bundles and reduced pith.

Transverse sections cut just beneath the calyx differ from the previously described sections by showing (1) an increased number of bundles in the outer bundle zone, (2) a dense, dark-colored central core of bundle tissues and, (3) a zone of loosely arranged parenchyma composed of chains of small, rounded parenchyma cells between the dark central core and the outer bundle zone.

The calyx and corolla both show secretion reservoirs imbedded in parenchyma between the upper and lower epidermis. The parenchyma is traversed by small bundles.

The **stamens** consist of (1) the *filament* region which exhibits an epidermis, parenchyma containing rosette aggregates of calcium oxalate and oil-reservoirs and a central region of bundle tissue; (2) *anther* which in cross section shows an outer epidermis of tangentially elongated cells, a layer of reticulated cells which are radially elongated and with beaded walls, an inner epidermis, and a central cavity containing triangular pollen grains with rounded angles.

**Histology of Clove Stem.**—Transverse sections of clove stem present for examination the following structures:

1. *Epidermis* similar to that of clove hypanthium.

2. *Cortex* consisting of an outer hypodermis of radially arranged stone cells beneath which occurs a zone of parenchyma containing an interrupted circle of oil-reservoirs similar to clove but fewer in number, and scattered stone cells which are large, irregular, polygonal, rounded to elongate in shape with prominent pore canals and irregularly-thickened walls. 3. *Pericycle*.

4. *Bicollateral Fibrovascular Bundles* arranged in a circle and separated by narrow medullary rays. Flanking these bundles on their outer face and on their inner face are pericyclic fibers, the outer fibers being somewhat larger than the inner ones. Each bundle shows an outer phloem and an inner phloem of

sieve tissue and phloem parenchyma and a centrally placed xylem, the latter containing scalariform and spiral tracheae arranged mostly in radial rows.

5. *Pith* of parenchyma and imbedded stone cells.

**Powdered Drug.**—Dark brown to reddish-brown, consisting mainly of cellular fragments showing the large oval, schizolysigenous oil reservoirs, spiral tracheae and a few somewhat thick-walled, slightly-lignified, spindle-shaped bast-fibers; calcium oxalate in rosette aggregates, from 10 to 15 $\mu$  in diameter; pollen grains numerous, tetrahedral, with rounded angles and up to 20 $\mu$  in diameter.

**Constituents.**—*Volatile oil* (14 to 20 per cent.) containing a phenol termed *eugenol* [C<sub>10</sub>H<sub>12</sub>O<sub>2</sub>], acetylene and the sesquiterpenes of  $\alpha$ - and  $\beta$ -*caryophyllenes*; eugenin (isomeric with eugenol), caryophyllin (an odorless and tasteless principle), vanillin, gallotannic acid (about 13 per cent.), calcium oxalate, etc. The volatile oil is official in the U.S.P. It contains from 50 to 85 per cent. of *eugenol* which is also official.

**Uses.**—Cloves are used as an aromatic, carminative, and condiment as well as in the manufacture of clove oil and vanillin.

**Average Dose.**—0.25 Gm. (4 grains).

**Preparations, N.F.**—Aromatic Chalk Powder, 2 Gm.; U.S.P., Compound Lavender Tincture, 2 cc., Aromatic Rhubarb Tincture, 4 cc.

**Adulterants.**—(1) Clove stems, identified chiefly by the presence of yellow, polygonal or irregular stone cells with pore canals and large lumina frequently filled with an orange or yellow amorphous substance and up to about 70 $\mu$  in diameter; cork elements and numerous scalariform and reticulate tracheae.

(2) Coconut shells, distinguished by having many stone cells of slenderly elongated shape and brownish-yellow walls with dark brown contents that become reddish-brown when mounts are examined in potassium hydroxide solution. Used only in ground form to adulterate powdered cloves as well as other ground spices.

(3) Olive pits, identified in powdered cloves by their stone cells which in water mounts are of a variety of shapes and have colorless walls and contents.

(4) Cereal flours, identified by their characteristic starches, hairs, etc.

(5) Mother of Cloves or Clove fruit, identified by its pyriform, clavate or ovate starch grains, often rounded-truncate at the narrower end, up to 40 $\mu$  in diameter, with a distinct hilum toward the broader end, by its knotty bast fibers which frequently possess 2-lobed ends, and irregular, often branched stone cells.

**Clove Oil (Oleum Caryophylli) U.S.P.** (Oil of Clove) is the volatile oil distilled with steam from the dried flower buds of *Eugenia caryophyllata* Thunberg. It contains not less than 82 per cent. by volume of eugenol. It is a colorless or pale yellow liquid becoming darker with age and possessing the odor and taste of clove. It is soluble in 2 volumes of 70 per cent alcohol; sp. gr., 1.038 to 1.060; opt. rot., not more than 1° 30' in a 100 mm. tube at 25°C.; ref. ind., 1.5290 to 1.5350 at 20°C. It is chiefly imported from Madagascar and the United King-

dom. Local anesthetic in toothache, carminative, germicide and flavoring agent. Average dose, 0.1 cc. (1½ minims).

**Eugenol U.S.P.** is a phenol obtained from clove and other sources. It occurs as a colorless or pale yellow, thin liquid having a strongly aromatic odor of clove and a pungent spicy taste. Powerful germicide and local anesthetic. It is used by dentists in the disinfection of root canals. Average dose, 0.1 cc. (1½ minims). **Preparation.**—Zinc-Eugenol Cement, N.F.

#### ARALIACEÆ (GINSENG FAMILY)

Herbs (*Panax quinquefolium* or American Ginseng, *Hedera Helix* or English Ivy, *Aralia nudicaulis* or Virginia Sarsaparilla, etc.), undershrubs (*Aralia hispida*, etc.), shrubs (*Oplopanax horridum* (Devil's Club), or trees (*Aralia spinosa*) with stems which are more or less hollow along internodes and solid at nodes. Leaves alternate, varying from simple in English Ivy (*Hedera*) to trifoliate or to multipinnate (tropical Aralias) or passing by telescoping into palmately compound. Leaves serrate-margined and along with stem they develop volatile oil, resin and gum contents, in secretion reservoirs. Inflorescence varying from a raceme of umbels to a raceme and even to condensed racemose umbels. Flowers regular, generally pentamerous, small, generally inconspicuous, green, greenish-yellow to rarely white, usually hermaphrodite but sometimes polygamous or dioecious; sepals 5, rarely 4; petals 5, rarely 4, often greenish to greenish-yellow, occasionally white, seldom pink in color; stamens varying from indefinite to 10 to commonly 5, opposite sepals, and, like sepals, epigynous in insertion; anthers versatile; pistil occasionally 15- to 10-, usually 5-carpellate; ovary as many celled with 1 or rarely 2 pendulous ovules in each cavity; styles distinct, ending in knob-shaped stigmas. Fruit a berry. Seeds albuminous.

#### ARALIA N.F. (ARALIA)

**Synonyms.**—Spikenard Root, *Spignet*, *American Spikenard*, Indian Root, *Fr. Nard Americain*; *Ger. Amerikanische Nard*.

**Botanical Origin.**—*Aralia racemosa* Linné.

**Part Used.**—The dried rhizome and roots.

**Purity Rubric.**—Not more than 5 per cent. of attached stem bases and not more than 2 per cent. of other foreign organic matter. It yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—Rich woods of Southern Canada and the United States, west to the Rocky Mountains.

**Plant.**—A perennial herb whose underground portion consists of a fleshy, oblique, aromatic rhizome bearing numerous roots. Its aerial portion consists of widely branched, unarmed stems arising to the height of 1 to 1.8 m. bearing ternately to quinate compound leaves, each with broadly ovate, membranous leaflets having acuminate apices, cordate bases and doubly serrate margins, and hairy on the veins beneath. The inflorescences consist of panicles of



umbels bearing small, greenish-yellow flowers. Each flower is composed of a tubular calyx adnate to the ovary and with a 5-toothed limb, a corolla of 5 greenish-yellow petals, 5 stamens inserted on the epigynous disk and a central pistil composed of an inferior 5-celled ovary and 5 styles which are connate below. The fruit is a sub-globular, dark purple to reddish-brown berry.

**Production and Commerce.**—The rhizomes and roots are gathered in autumn, frequently sliced lengthwise to facilitate drying and carefully dried. The commercial supplies come chiefly from the states of North Carolina, Virginia, Indiana, Illinois, Missouri and Washington.

**Description.**—*Rhizome* oblique, somewhat flattened, tortuous, annulate between stem scars, usually cut longitudinally, up to 5 cm. in thickness; externally weak reddish brown to weak yellowish-orange, scaly; nodes closely arranged, each with a prominent, depressed stem scar about 3 cm. broad; fracture fibrous; internally whitish; *roots* numerous of variable length, from 5 to 25 mm. in thickness, usually cut lengthwise and furrowed, sometimes with transverse ridges and cork patches; externally pale red-purple to weak yellowish orange, the cut surfaces whitish and spongy internally; fracture of bark short, of wood short and fibrous; odor aromatic; taste mucilaginous, pungent and slightly acrid.

**Histology.**—Sections of the root exhibit a well developed cork; one or more hypodermal layers with lignified cells from  $40\mu$  to  $100\mu$  in length and about half as broad having walls with simple pores (distinction from *A. nudicaulis* root); a broad cortex of cortical parenchyma cells, some containing spherical or angular, simple or 2-4 compound starch grains, the individual grains up to  $25\mu$  in diameter, others possessing rosette aggregates of calcium oxalate up to  $70\mu$  in diameter; several rows of secretion reservoirs, containing oil and resin, course through the cortex; a soft bast; a cambium; a broad distinctly radiate wood showing tracheæ with reticulate or scalariform thickenings and simple or bordered pores.

**Powdered Drug.**—Light yellowish brown. Numerous simple or 2- to 4-compound starch grains, the individual grains spheroidal or somewhat angular and up to  $25\mu$  in diameter; rosettes of calcium oxalate up to  $70\mu$  in diameter; tracheæ with simple and bordered pores and scalariform and reticulate tracheæ; characteristic lignified hypodermal cells up to  $100\mu$  in length and about one-half as broad with walls showing simple pores; lignified sclerenchyma fibers from pericycle.

**Constituents.**—*Volatile oil* (0.33 per cent.); a glycosidal saponin called *araliin*; resin (3 per cent.), starch, tannin, pectin, sugar, and calcium oxalate.

**Uses.**—Stimulant and diaphoretic. A constituent of syrup of white pine compound.

**Average Dose.**—2 Gm. (30 grains).

**Preparations.**—Compound White Pine Syrup, 4 cc.; Compound White Pine Syrup with Codeine, 4 cc.

**Allied Drug.**—The rhizome of American-, Wild-, or Virginian-Sarsaparilla, *Aralia nudicaulis* L., a low perennial herb with a long, aromatic rhizome bearing

a single, long-stalked, pinnately-compound leaf, the blade having 3 divisions each bearing a series of leaflets, and a shorter naked scape bearing 2-7 umbels of green flowers. This is grayish-brown, deeply longitudinally wrinkled, seldom cut longitudinally, shows alternate undeveloped buds, few roots, possesses a short fracture, the fractured surface whitish and showing a spongy and starchy pith. The taste is aromatic, bitter and pungent. An outstanding distinction from Spikenard is the absence in this rhizome of *lignified hypodermal cells with porous walls*. The uses and dose are similar to Spikenard.

### GINSENG

**Synonyms.**—Ginseng Root, Radix Ginseng, Schinzent; *Ger.* and *Fr.* Ginseng.

**Botanical Origin.**—1. American Ginseng—*Panax quinquefolium* Linné. 2. Chinese Ginseng—*Panax Schinseng* Nees.

**Part Used.**—The dried root.

**Habitat.**—1. Eastern North America in woodlands. 2. Eastern Asia in mountains.

**Plants.**—Perennial herbs with fleshy, often forked roots, stems bearing a single whorl of 3 palmately compound leaves, a solitary stalked umbel of greenish white flowers, and bright red fruits.

**Production and Commerce.**—Most of the drug is collected from plants which are cultivated in various parts of the United States and Canada (American Ginseng) and in China, Korea and Japan (Chinese Ginseng). The plants are propagated from seeds which should be sown in light loam rich in humus and in the shade of woodland or orchard. Well drained land and some cultivation are necessary for a good crop. The roots are dug from 3 to 7 year old plants in late summer or autumn, washed, and carefully dried. 122,900 lbs. of American Ginseng were exported in 1947. Chinese Ginseng roots are specially treated by an unknown process which renders them somewhat translucent and horny. Similar results can be obtained by treating the fresh, cleaned roots with recently slaked lime. Most of the roots grown in this country are exported to China. Small lots of roots from wild plants are gathered in North Carolina and Kentucky. Some American Ginseng is imported from Canada.

**Description.**—Subcylindrical, somewhat spindle-shaped, fleshy, and frequently 2- to several branched in lower portion, up to 12 cm. in length and up to 2.5 cm. in thickness, the upper portion with a crown showing one or more stem scars and annulations; lower portion annulated, irregularly longitudinally wrinkled and exhibiting root scars; the external color varying from yellowish-white (American and Chinese) to yellowish-brown (Korean); fracture short; internally pale yellowish to yellowish-brown and exhibiting a broad, soft, whitish bark, a dark brown cambium line and a distinctly radiate, hard wood; scattered through the bark and wood are numerous oil and resin canals; odor slightly aromatic; taste sweetish, aromatic, mucilaginous and slightly bitter.

**Constituents.**—A glycoside called *panaquilon* ( $C_{32}H_{50}O_{14}$ ), *Panax saponinol*, *volatile oil*, resin, a phytosterin, mucilage, a sugar, starch, etc.

**Uses.**—Ginseng is used by the laity as a stimulant and aromatic bitter. The Chinese also employ it as an aphrodisiac and heart tonic but without scientific justification.

**Average Dose.**—2 Gm. (30 grains).



FIG. 303.—Ginseng (American)  $\times \frac{1}{2}$ .

**Allied Drug.**—Japanese Ginseng represents the dried rhizome of *Panax repens*, a native of Japan. It contains about 20 per cent. of a saponin, volatile oil and resin.

#### UMBELLIFERÆ (PARSLEY FAMILY)

Herbs, rarely shrubs, often of rapid growth, and with upright, fistular (hollow at internodes, solid at nodes), often grooved and ridged stems. Leaves alternate, compound and usually much divided, exstipulate, but with expanded sheathing and flattened leaf base (pericladium), that ensheathes the stem. Inflorescence a simple or often compound umbel surrounded by an involucre of bracts or of bracteoles. Flowers small, pentamerous, with inferior ovary and superior floral parts. Sepals minute, tooth-like, inserted above inferior ovary, or absorbed. Petals small, usually yellow to white, rarely pink to purple, distinct, each with inflexed tip. Stamens five, epigynous, inserted below a

nectariferous, epigynous disc, incurved in bud. Carpels two, fused into bicarpellate pistil. Ovary two-celled, with one pendulous ovule in each cell, ovarian wall traversed by oleoresin canals called vittæ; styles two, distinct above the nectar disc or stylopod. Fruit a dry, splitting fruit or cremocarp, that splits lengthwise into two mericarps which hang for a time by a forked carpophore. Seeds single in each mericarp, albuminous.

The chief histological characteristics are the presence of schizogenous oleoresin canals in the cortex of the root and stem and in the mesocarp of most of the fruits, the usual presence of collenchyma in the stem primary cortex and in the ribs of the fruits, simple perforations in the tracheæ, the absence of glandular hairs, the presence of non-glandular hairs in many species and the occurrence of calcium oxalate in rosette aggregates and solitary crystals. Some species including *Ferula* spp. possess pith bundles in addition to the normal circle of vascular bundles. Pith disappears in the stem internodes.

#### ANISUM N.F. (ANISE)

**Synonyms.**—Anise Seed, *Aniseed*, Sweet Cumin; *Fr. Anis*; *Ger. Anissame*.

**Botanical Origin.**—*Pimpinella Anisum* Linné.

**Part Used.**—The dried ripe fruit.

**Purity Rubric.**—Not more than 3 per cent. of foreign organic matter; it yields not more than 1.5 per cent. of acid-insoluble ash and not less than 1.75 cc. of volatile oil of anise from each 100 Gm. of drug.

**Ash.**—Not more than 9 per cent. of total ash nor more than 1.5 per cent. of ash insoluble in hydrochloric acid (S. R. A., F. D. A., No. 2, Rev. 5, U.S. Dep. Agr., Nov. 1936).

**Habitat.**—Asia Minor, Greece and Egypt.

**Plant.**—An annual herb with an erect, cylindrical, striated, smooth stem arising to the height of about .3 m. Its leaves are alternate below, opposite above, the lower long-petioled, ovate to orbicular, dentate, the upper with short dilated petioles, pinnatifid or ternately pinnate with long, entire or cut, cuneate segments. The inflorescences are long-stalked, 8- to 14-rayed, compound umbels. The flowers are small, white in color, each on a long hairy pedicel. The fruit is a mouse-shaped cremocarp of a small stylopod and 2 minutely pubescent mericarps which do not readily separate from the carpophore. Fig. 305(1).

**Production and Commerce.**—Anise has been cultivated in Egypt, Asia Minor and southern Europe for many centuries. It has also been cultivated in many sections of this country, in India, Mexico and South America. It is propagated from seeds (fruits) which are sown in early spring directly in the field. The soil should be moderately rich, well drained loam with added humus and lime. When the seedlings are 2 or 3 inches high they are thinned so as to be about 8 inches apart in a row. Ample space should be allotted between the rows for cultivation. The drug should be collected as soon as the summits of the fruits assume a grayish-green color. In harvesting, the plants are pulled up by hand or mowed down and stacked in tall heaps for about 4 or 5 days until

the fruits have ripened. The fruits are then separated by thrashing and carefully cleaned.

The leading commercial varieties of Anise before the last world war were as follows: Mexican, Bulgarian, Spanish, Italian, Russian, Levant and French. The Spanish or Alicante Anise, obtained from plants cultivated in Spain has been the variety in greatest esteem in this country. In 1947, the commercial supply was obtained from plants cultivated in this country, Mexico, Syria, China, Egypt, India, Hong Kong, and Malta.



FIG. 304.—*Pimpinella Anisum* L., source of Anise Seed and one of the sources of Anise Oil. Below, to right and left, lower leaves.  $\times \frac{1}{2}$ .

**Description.**—Cremocarp broadly ovoid or pyriform, laterally compressed, from 3 to 7 mm. in length and from 2 to 3 mm. in breadth; mericarps usually cohering and attached to a slender pedicel from 2 to 12 mm. in length; summit with a ring-like stylopodium (disk) and two projecting, diverging styles; externally moderate brown to light yellowish brown, slightly pubescent; each mericarp with 5 light-colored filiform ridges; odor and taste characteristically aromatic, resembling *Illicium*.

**Histology.**—Transverse sections of the cremocarp show the following microscopical peculiarities:

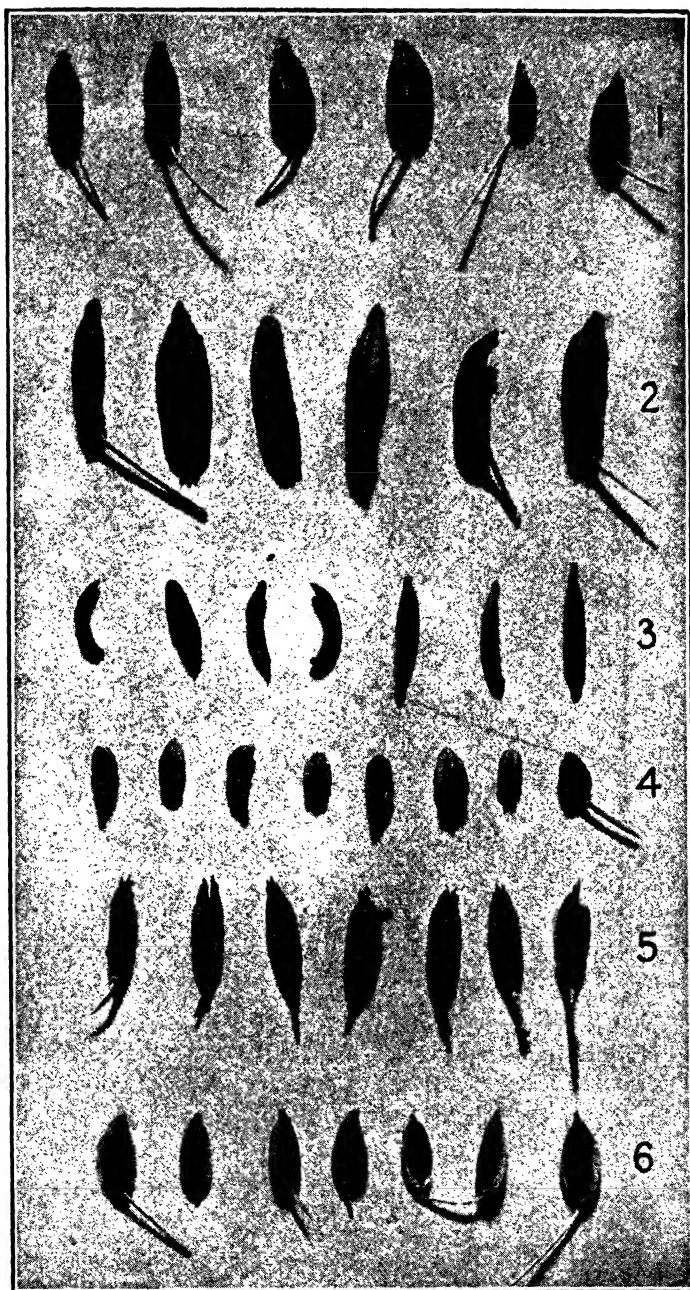


FIG. 305.—Umbelliferous fruits. 1, Anise; 2, Fennel; 3, Caraway; 4, Conium; 5, Cumin; 6, Dill.  $\times 3$ .

Two *mericarps*, each, 5 ribbed, of reniform outline and with a carpophore separating their concave commissural surfaces. Examination of one of the *mericarps* reveals the following:

1. *Epicarp*, consisting of a layer of outer yellowish-brown epidermal cells having numerous papillæ and short, unicellular, non-glandular hairs with thick papillose walls.

2. *Mesocarp* of several layers of tangentially-elongated parenchyma cells in the dorsal part of which region are to be noted 15 to 45 vittæ, and in the commissural side, 2 large vittæ. In each of the primary rib parts of this region will be noted a small fibrovascular bundle surrounded by a few sclerenchyma fibers.

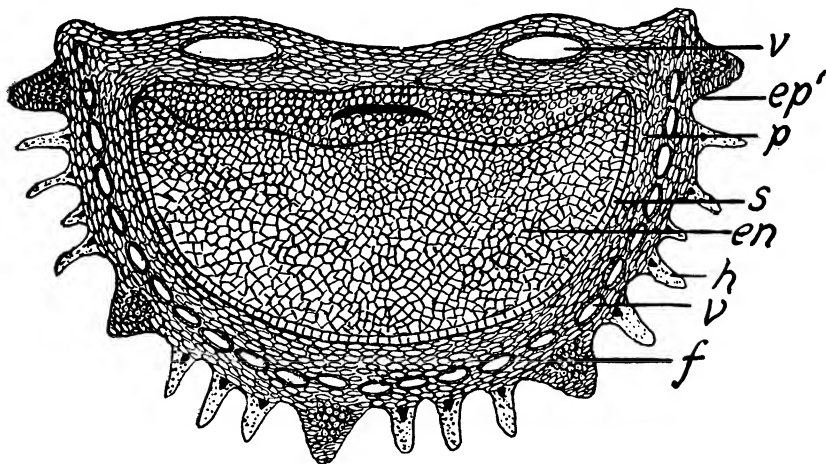


FIG. 306.—Anisum. Transverse section of *mericarp*. Epicarp (*ep*); parenchyma of mesocarp (*p*); vittæ (*v*); spermoderm (*s*); hair (*h*); fibrovascular tissue in one of the primary ribs (*f*); endosperm (*en*). The two larger vittæ are on the commissural side; the smaller vittæ are on the dorsal side. The layer of cells directly outside of the spermoderm is the endocarp. Above the endosperm is the raphe containing a dark crescent (fibrovascular tissue).

3. *Endocarp*, consisting of a layer of tangentially-elongated, thin-walled cells closely adherent to the seed coat, except near the middle line of the commissural side where the endocarp cells may have thick porous or reticulate walls resembling stone cells.

4. *Spermoderm* or seed coat, comprising a layer of tangentially-elongated cells with thickened, yellow to greenish-yellow inner walls. The seed coat is closely united with the endocarp except where separated by a large cavity along the commissural side.

5. *Endosperm* of numerous, thick-walled, polyhedral cells containing globules of fixed oil and aleurone grains, each of the latter usually containing a small rosette aggregate of calcium oxalate.

Sections cut through the upper portion of the *mericarp* show *embryo* in center of endosperm.

**Powdered Drug.**—Moderate yellowish-brown to light olive-brown; numerous fragments of the pericarp showing parenchyma, imbedded in some of which will

be noted the yellowish or brown vittæ or walls of vittæ; fragments of yellowish-brown epicarp cells, some showing short papillose outgrowths, others unicellular non-glandular hairs up to  $200\mu$  long and with thick, yellowish, lamellated walls; fragments of carpophore, showing sclerenchyma fibers; fragments of fibro-

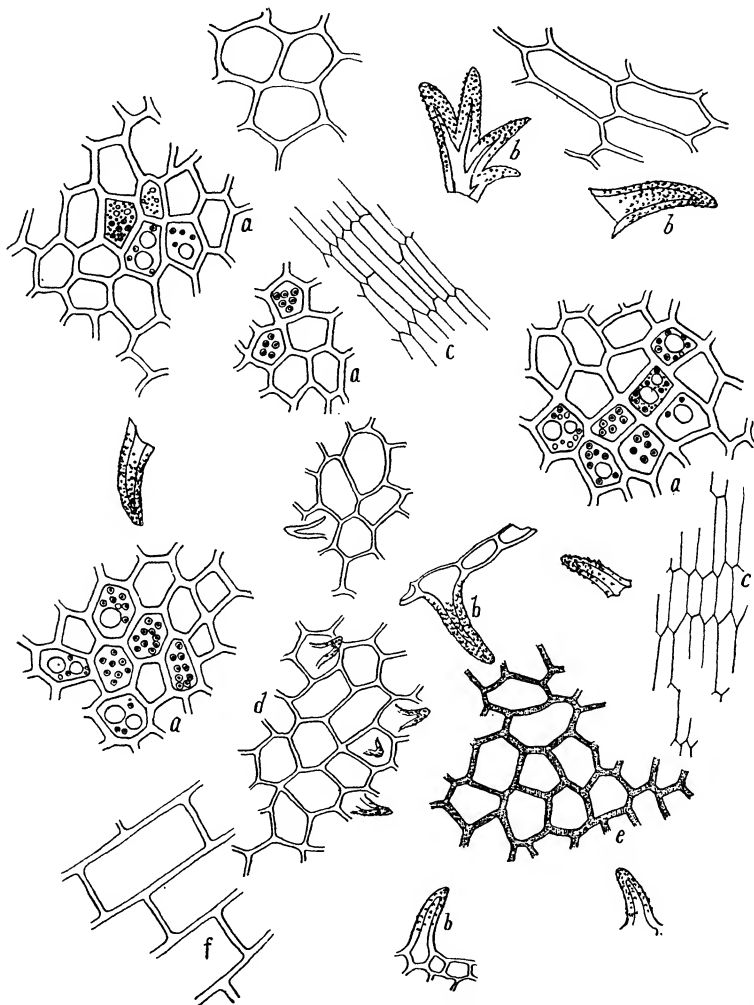


FIG. 307.—Powdered Anisum. (a) Endosperm cells with aleurone grains and oil globules; (b) trichomes; (c) thin-walled parenchyma of testa; (d) epidermal cells of pericarp with trichomes; (e) reddish-brown cells of pericarp; (f) parenchyma, longitudinal view. (Schneider.)

vascular tissue; numerous fragments of the endosperm, consisting of polygonal, thick-walled cells with aleurone grains about  $6\mu$  in diameter in each of which will usually be noted a tiny rosette aggregate of calcium oxalate, about  $4\mu$  in diameter.

**Constituents.**—Up to 3 per cent. of *volatile oil* containing *anethol*; fixed oil, calcium oxalate, etc.



**Uses.**—Stimulant, carminative and flavoring agent; a source of Oil of Anise U.S.P. It is extensively used by the bakery and confectionery trades to flavor their products.

**Average Dose.**—0.5 Gm. (8 grains).

**Preparation.**—Sweet Rhubarb Tincture, N.F., 4 cc. (1 fl. dr.).

**Anise Oil (Oleum Anisi) U.S.P.** or Oil of Anise is the volatile oil distilled from the dried ripe fruit of *Pimpinella Anisum* (Fam. *Umbelliferae*) or from the dried ripe fruit of *Illicium verum* (Fam. *Magnoliaceae*). If solid material has separated the oil should be carefully warmed until completely liquefied before it is dispensed. Stimulant, carminative, aromatic; flavoring agent. Av. dose, 0.1 cc. (1½ minims). U.S.P. Prep.—Anise Water. N.F. Prep.—Anise Spirit.

**Anethole N.F.** ( $C_6H_4.C_3H_5.OCH_3$ ) is paraprophenyl anisole. It is the main constituent of the oils of anise, star anise and fennel and is obtained from these by fractionating, chilling and crystallizing. It is also prepared synthetically. Stimulant, carminative and flavor. Average dose, 0.1 cc. (1½ minims). Enters into Anisated Ammonia Spirit and Compound Cardamom Spirit, N.F.

**Adulterants.**—Foreign seeds, and fruits, pebbles, exhausted fruits, and Conium. The latter is poisonous and may readily be detected by triturating a portion of a suspected sample with an alkaline solution, when an odor resembling mouse urine develops.

### ✓ FENNEL N.F. (FENICULUM)

**Synonyms.**—*Fennelseed*, Fennel Fruit; *Ger.* Fenchelsamen; *Fr.* Fenouil.

**Botanical Origin.**—Cultivated varieties of *Feniculum vulgare* Miller.

**Part Used.**—The dried ripe fruit.

**Purity Rubric.**—Not more than 4 per cent. of foreign organic matter; it yields not more than 1.5 per cent. of acid-insoluble ash.

**Ash.**—Not more than 9 per cent. of total ash, nor more than 2 per cent. of ash insoluble in hydrochloric acid (S.R.A., F.D.A., U.S. Dep. Agr. Rev. 5, 1936).

✓ **Habitat.**—Southern Europe and Asia Minor.

**Plants.**—Perennial aromatic herbs attaining a height of about 1 m. with green, glaucous, furrowed, branched stems bearing alternate, twice pinnate leaves with narrow pinnae, small yellow flowers in compound umbels and oblong cremocarps.

**Production and Commerce.**—Fennel is cultivated on a large scale in British India, Argentina, Saxony, Germany, in Spain, Italy, Russia, France, Roumania, and Japan and to a lesser extent as a garden herb in this country. It thrives best in well drained garden soil which has been limed. It is propagated from fruits sown directly in the field after preparation of the ground or by sowing in seed beds first and later transferring seedlings to the field. The seedlings should stand about 15 inches apart in rows with ample space left between these for cultivation. The fruits are collected similarly to those of anise and packed in bags for shipment.

There is quite a difference between the fennels. The German large is green

in color. The French, Italian, Levant and Indian fennels are yellow. The Roumanian is a small green fruit which is not highly prized.

**Description.**—Cremocarps nearly cylindrical, from 4 to 15 mm. in length and from 1 to 3.5 mm. in breadth, some with a slender pedicel up to 10 mm. in



FIG. 308.—*Foeniculum vulgare* Miller,  $\times \frac{1}{2}$ , source of Fennel Seed and Fennel Oil.

length and at the summit a short conical stylopodium. Mericarps frequently separate, each being broadly elliptical, more or less curved; dorsal surface convex, light brown to light olive with 5 prominent, longitudinal primary ribs, and at the summit a short, conical stylopodium; commissural surface flat, with

3 narrow, light-colored areas separated by 2 darker colored areas containing vittæ (oil tubes); odor and taste characteristically aromatic. [See Fig. 305(2).]

**Histology.**—Transverse sections of the mericarp, when examined with a hand lens, show a pentagonal outline, four of the dorsal sides being nearly equal and slightly concave, the commissural side being considerably longer and somewhat undulate. The ribs are large and wing-like. When examined under a compound microscope, the following microscopical details are noted:

1. *Epicarp*, consisting of a layer of clear, tangentially-elongated epidermal cells.

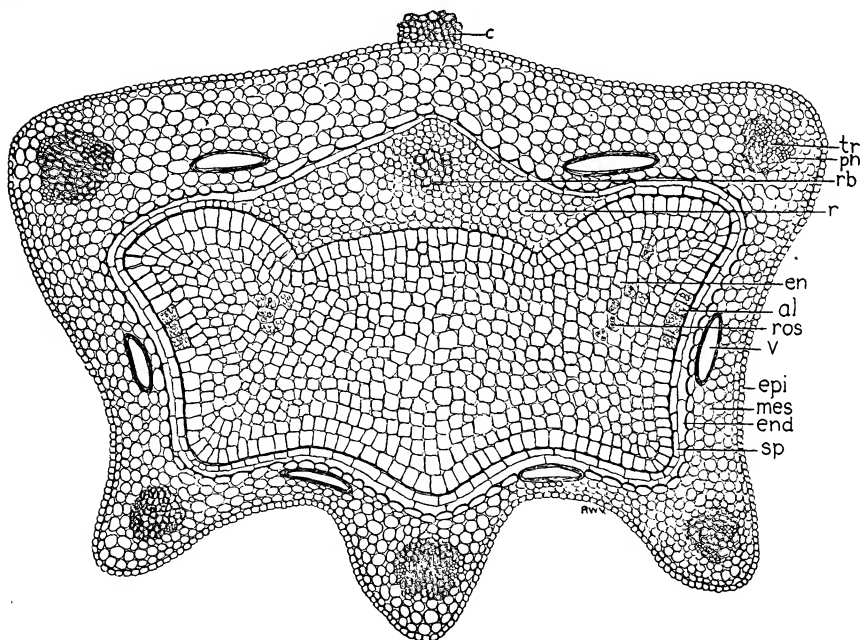


FIG. 309.—Fennel Fruit (*Faniculum vulgare*). A mericarp with attached carpophore (*c*) in transverse section. *epi*, epicarp; *mes.*, mesocarp; *end*, endocarp; *sp*, spermoderm; *v*, vitta; *r*, raphe; *rb*, raphe bundle; *en*, endosperm of seed containing aleurone grains (*al*) and fixed oil; *ros*, rosette aggregate crystal of calcium oxalate in aleurone grain. (Drawing by R. W. Vander Wyk.)

2. *Mesocarp* of several layers of thin-walled parenchyma cells; in the commissural region of this zone are usually 2, occasionally 4 large elliptical vittæ with brown walls; in the dorsal region between each 2 primary ribs will be observed similar vittæ, there being 6 to 8 in the entire mesocarp; in the center of each of the rib portions of the mesocarp occurs a nearly circular fibrovascular bundle with a few spiral, annular and simple pored tracheæ and numerous, thin-walled, strongly lignified, sclerenchyma fibers. Surrounding the bundle are many brownish parenchyma cells with reticulate and porous markings on their walls when viewed in surface sections.

3. *Endocarp*, a narrow layer of cells, transversely-elongated, except over the region of bundles where the cells are arranged in groups which extend in different directions giving this layer as seen in surface view a parquetered appearance.

4. *Spermoderm* or seed coat, consisting of a layer of somewhat broadened epidermal cells attached to the endocarp, beneath which are several layers of more or less collapsed cells which are best defined in the region of the raphe. The raphe will be found as a somewhat crescent-shaped band of thick-walled cells just outside the center of the commissural region of the seed coat.

5. *Endosperm*, a large somewhat reniform zone of thick-walled polygonal cells containing aleurone grains and fixed oil globules. Each aleurone grain generally contains a rosette aggregate of calcium oxalate from  $2\mu$  to  $5\mu$  in diameter and one to two globoids.

6. *Embryo*, embedded in the endosperm of the upper region of the seed with its hypocotyl directed upward.

**Powdered Drug.**—Yellowish-brown; numerous colorless, irregular, angular fragments of endosperm with thick-walled cells containing aleurone grains up to  $10\mu$ , each containing a tiny rosette of calcium oxalate up to  $5\mu$  in diameter; fragments of brownish reticulate parenchyma of the mesocarp; fragments containing yellow or brownish vittæ, the latter up to  $200\mu$  in width; fibers few, strongly lignified with oblique pores; tracheæ and tracheids few with spiral and annular thickenings; fragments containing characteristic narrow, elongated endocarp cells which in surface view over the bundles are arranged in groups extending in different directions.

**Constituents.**—Up to 6.5 per cent. of *volatile oil* (*Oleum Fœniculi* U.S.P.) containing *anethol* and *fenchone*, fixed oil, calcium oxalate, etc.

**Uses.**—Stimulant, carminative, galactagogue and condiment; source of volatile oil of fennel.

**Average Dose.**—1 Gm. (15 grains).

**Preparation.**—Cataria and Fennel Elixir, N.F., 0.5 cc. (8 minims).

**Fennel Oil** (*Oleum Fœniculi*) U.S.P. is the volatile oil distilled from the dried ripe fruit of *Fœniculum vulgare* (Fam. *Umbelliferae*). If solid material has separated, the oil should be carefully warmed at a low temperature until completely liquefied, and it should be thoroughly mixed before it is dispensed. Stimulant, carminative. Average dose, 0.1 cc. ( $1\frac{1}{2}$  minims). Preparations: Fennel Water, U.S.P., Glycyrrhiza Syrup, U.S.P., Carminative Mixture, N.F., Compound Senna Powder, N.F.

**Adulterants.**—(1) Fruits of other *Umbelliferae*, notably *F. piperitum* (from Italy) which has a bitter taste and *Meum athamanticum*. (2) Fruits of grasses, cereals, etc.; (3) Undeveloped fennel fruits; (4) Moldy fennel fruits; (5) Dirt.

#### CARAWAY U.S.P. (CARUM)

**Synonyms.**—*Caraway Fruit*, *Caraway Seed*; *Ger.* Kümmelsamen; *Fr.* Fruit de Carvi, Cumin des Prés.

**Botanical Origin.**—*Carum Carvi* Linné.

**Part Used.**—The dried ripe fruit.

**Purity Rubric.**—Not more than 3 per cent. of other fruits, seeds or foreign organic matter. It yields not more than 1.5 per cent. of acid-insoluble ash.

**Ash.**—Not more than 8 per cent. of total ash, nor more than 1.5 per cent. of ash insoluble in hydrochloric acid (S.R.A., F.D.A., Rev. 5, U.S. Dep. of Agr., 1936).

**Habitat.**—Asia and Europe. Naturalized in United States and Canada.

**Plant.**—A biennial herb sending up the first season a cluster of bi- to tri-pinnate root leaves. During the second year there arises a slender stem bearing alternate, pinnate to bipinnate leaves, the terminal segments of which are quite narrow and pointed. These cauline leaves have large sheathing brown petioles. The inflorescence is a long-stalked compound umbel bearing small white flowers with small calyx teeth, the petals ovate and notched, the stylopod conical. The fruits are oblong, laterally compressed, dark brown cremocarps.

**Production and Commerce.**—Caraway has long been cultivated in Germany, Holland, Morocco, Spain, Norway, Russia, England and to a lesser extent in the northern part of the United States. The plant thrives well in black top soil or subclay or subsandy soil containing some humus. The seeds are sown in spring in drills about 18 inches apart. Shallow cultivation is essential to keep down weeds. The plants are mowed down when the oldest fruits are ripe, dried in the field or in the barn loft until they have lost most of their moisture, after which the fruits are thrashed out, cleaned and stored in bags. Most of the commercial supply used by this country has been imported from Amsterdam and Rotterdam, Holland, Poland and Danzig, Russia, Denmark, Rumania and British India, in burlap bags. During 1947, 3,320,484 lbs. of Caraway seed were imported into this country, most of which came from Netherlands, Syria, Canada and Poland. Occasional lots of African seed are imported through Marseilles and London. This usually comes in "bearded" form, having the pedicels attached. During 1945, 18,411 pounds of caraway oil were imported into this country from Netherlands and Russia. Caraway should be stored in well-closed containers and protected against attack by insects.

**Description.**—Mericarps usually separated, crescent shaped, 3 to 7 mm. in length 1.5 to 2 mm. in diameter, externally dark brown to weak brown with 5 lighter-colored filiform primary ribs between each pair of which, on the dorsal surface, occurs a secondary rib; in cross section nearly equilaterally pentagonal, the commissural surface with 2 vittæ, the dorsal surface with a vitta between each two primary ribs; oily endosperm large, embedded in the upper end of which is a small embryo; odor and taste characteristically aromatic.

**Histology.**—Transverse sections, cut through the center of the equilaterally pentagonal mericarp, show the following structures;

1. *Epicarp* consisting of an outer layer of slightly tangentially-elongated epidermal cells with thick outer walls. In surface sections, the outer walls show a striated cuticle.

2. *Mesocarp*, a zone of several rows of more or less collapsed, tangentially-elongated parenchyma cells. In each of the rib portions of this zone will be noted a fibrovascular bundle containing spiral tracheæ surrounded by a layer of thick-walled sclerenchyma fibers. On the commissural side will be noted 2 large vittæ, and, at the middle portion, 2 large transverse hollow spaces

formed by the separation of the tissues of the seed coat on one side and the pericarp on the other. On the dorsal side there are 4 large vittæ, one between each 2 primary ribs. Each vitta is elliptical, brown, and lined by small epithelial secretory cells.



FIG. 310.—*Carum Carvi* L., the source of Caraway "seed" and oil.  $\times \frac{1}{3}$ .

3. *Endocarp*, composed of a layer of broad, tangentially-elongated, inner epidermal *cross cells* closely adherent to the seed coat. These, in surface section, have slightly wavy walls.

4. *Spermoderm*, a layer of somewhat collapsed brownish cells.

5. *Endosperm*, a large zone of thick-walled, polygonal, reserve parenchyma cells containing droplets of fixed oil and aleurone grains, the latter not infre-

quently containing a small rosette aggregate of calcium oxalate up to  $4\mu$  in diameter.

**Embryo** embedded in the upper end of the endosperm.

**Powdered Drug.**—Yellowish-brown to brown; numerous polygonal endosperm cells, containing aleurone grains, each aleurone grain up to  $10\mu$  in diameter and usually containing a rosette aggregate up to  $4\mu$  in diameter; fragments of rib tissue with stone cells, fragments of orange to yellow vittæ together with

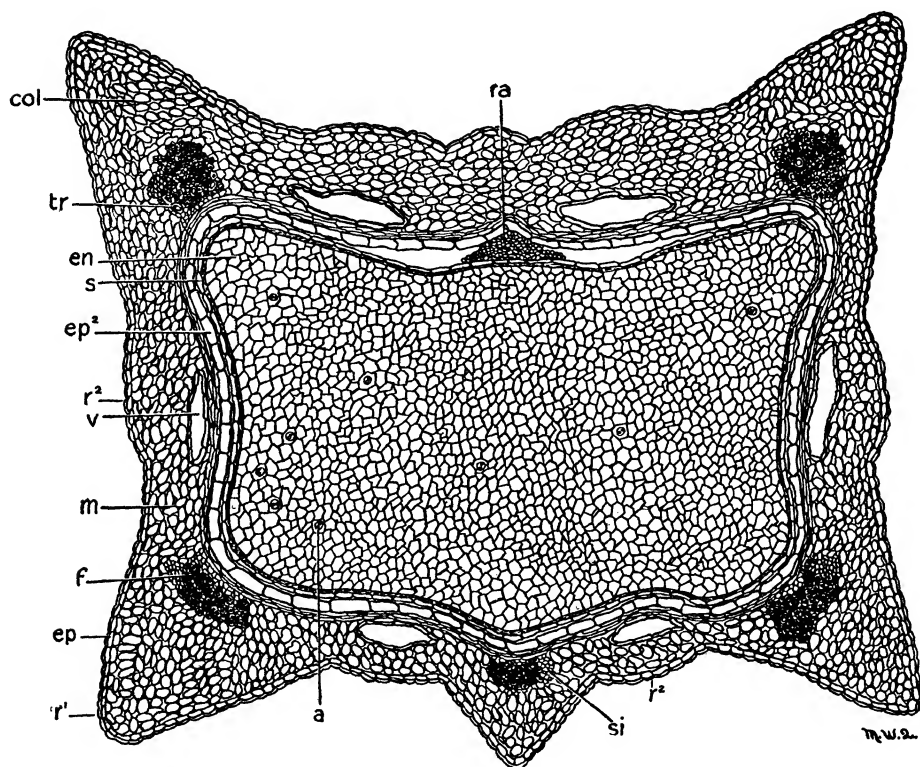


FIG. 311.—Transverse section of Caraway Fruit. *r*, primary rib; *r*<sup>2</sup>, secondary rib; *ep*, epicarp; *m*, mesocarp; *ep*<sup>2</sup>, endocarp; *s*, spermoderm; *en*, endosperm; *tr*, tracheæ; *f*, sclerenchyma fibers and *si*, sieve tubes of fibrovascular bundles found in mesocarp region of primary ribs; *ra*, raphe of anatropous seed; *col*, collenchyma tissue occurring between bundle and epicarp in each primary rib. (Drawing by Quimby.)

yellowish-brown cross cells of endocarp (crossing vittæ); walls of vittæ; fragments containing slightly lignified sclerenchyma fibers having oblique walls, sometimes associated with a few spiral tracheæ; fragments of epicarp with polygonal cells showing a striped cuticle and stomata. No reticulate parenchyma occurs in caraway.

**Constituents.**—*Volatile oil* (5–7 per cent), fixed oil, tannin, etc. The volatile oil contains *carvone* (*d*-carvone) (up to 60 per cent) *dl*-limonene, dihydrocarvone, carveol, and a small quantity of a base having a narcotic odor.

**Uses.**—Stimulant, carminative, condiment and flavoring agent; source of oil of caraway. It is used in the food industry for flavoring bread, cheese and candy, also in the production of cordials.

**Average Dose.**—1 Gm. (15 grains).

**Preparation.**—Compound Cardamom Tincture, U.S.P., 4 cc. (1 fl. dr.).

**Caraway Oil** (*Oleum Cari*) N.F. (Oil of Caraway) is the volatile oil distilled from the dried, ripe fruit of *Carum Carvi* Linné (Fam. *Umbelliferae*). It yields not less than 50 per cent. by volume of *carvone* [ $C_{10}H_{14}O$ ]. Stimulant, carminative, corrective; in the flavoring of food preparations, sauces and pharmaceutical preparations, in cordials, and in the perfuming of soaps. Average dose, 0.1 cc. (1½ minims). N.F. Preparations: Carminative Mixture, Compound Cardamom Spirit.

**Adulterants.**—(1) Ergotized Caraway, detected by bluish-black sclerotia; (2) Mogador Caraway from Morocco; (3) Cumin which is the fruit of *Cuminum Cyminum* L., an annual herb, indigenous to northeast Africa. This fruit may readily be distinguished from Caraway by its mericarps which are usually coherent, forming an oblong cremocarp about 6 mm. in length which is rough bristly hairy along the ribs, and by its peculiar odor; (4) Fruits of *Aegopodium podagraria* L. which are dark brown to brownish-black, smaller, with less distinct ribs, the mericarp being rounded in cross section with a flat commissural surface. There are 4 small vittæ in each mericarp.

#### CELERY FRUIT (APII FRUCTUS)

**Synonyms.**—Celery Seed; *Ger.* Epich; *Fr.* Ache celeri.

**Botanical Origin.**—*Apium graveolens* Linné.

**Part Used.**—The dried ripe fruit.

**Purity Rubric.**—Not more than 5 per cent. of foreign organic matter. It yields not more than 3 per cent. of acid-insoluble ash, and not less than 1.75 cc. of volatile oil of celery fruit from each 100 Gm. of drug. N.F. VII.

**Ash.**—Not more than 10 per cent. of total ash, nor more than 2 per cent. of ash insoluble in hydrochloric acid (S.R.A., F.D.A., 1936).

**Habitat.**—Southern Europe.

**Plant.**—A biennial (sometimes annual) herb widely cultivated in this country and abroad for its leaves, root and fruit. The mature leaves are averagely 6 to 15 in. long and possess 3 pairs and a terminal leaflet, all coarsely serrate and ternately lobed or divided. The inflorescence is a compound umbel of small white flowers. The fruit is a minute, brown, roundish-ovate cremocarp.

**Commercial.**—Prior to the war celery fruit was shipped to the United States in bags chiefly from Marseilles, France, and from British India. Smaller lots were imported from London and Nimes, Netherlands and Japan. It is now being partly supplied from domestic crops grown in Michigan and Wisconsin. During 1947, India, France and China shipped 174,844 lbs. to this country.

**Description.**—Cremocarps ovoid, laterally compressed, occasionally with pedicel; mericarps usually separated, ovoid, slightly curved, from 1 to 2 mm.



in length, and about half as broad and thick, weak brown to olive brown; commissural surface flat, the dorsal surface convex, smooth, except for very slender light colored ribs, two of which are marginal, three dorsal; oil tubes (vittæ) in the mesocarp, 2 on the commissural and generally 1 to 3 between each 2

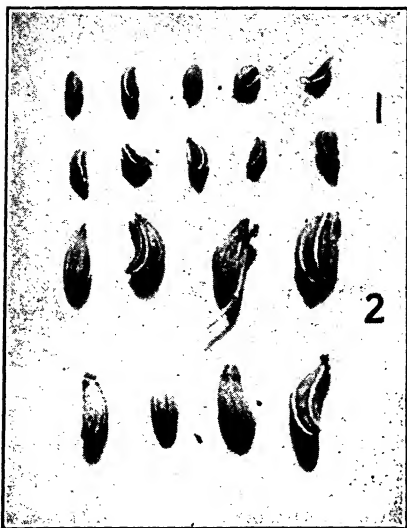


FIG. 312.—1, Celery fruit. 2, Parsley Fruit. ( $\times 4$ ). Note relative size.

primary ribs on the dorsal side; odor agreeably aromatic; taste aromatic, warm and pungent.

**Histology.**—Transverse sections cut through the middle region of a mericarp show it to be nearly equilaterally pentagonal with somewhat convex surfaces and to exhibit the following internal structures:

1. *Epicarp*, a layer of tangentially-elongated epidermal cells with a thick cuticle, a few of the cells being papillose.

2. *Mesocarp*, composed of a matrix of polygonal-shaped parenchyma cells imbedded in which are 4- to 15-vittæ, 2 of which are on the commissural side and generally 1 to several vittæ between each 2 primary ribs on the dorsal side.

In this region, also, will be noted a fibro-

vascular bundle with a few tracheæ in each primary rib that is surrounded by thick-walled, lignified sclerenchyma fibers.

3. *Endocarp*, composed of a layer of tangentially elongated cells with yellowish orange to greenish yellow walls.

4. *Spermoderm*, of collapsed yellowish orange to greenish yellow cells.

5. *Endosperm*, of polygonal, thick-walled, reserve parenchyma cells containing globules of fixed oil and aleurone grains, the latter containing rosette aggregates of calcium oxalate varying from 2 to  $8\mu$  in diameter.

**Powdered Drug.**—Moderate yellowish brown. The diagnostic elements include fragments of the pericarp with epidermal cells showing a few papillæ, portions of yellowish vittæ, tracheæ and fibers, numerous fragments of endosperm, numerous aleurone grains, many with a rosette aggregate of calcium oxalate from 2- to 8-microns in diameter.

**Constituents.**—Up to 3 per cent. of a colorless *volatile oil* containing *d*-limone which is found, as in other umbelliferous fruits, in the vittæ; fixed oil, etc.

**Uses.**—Stimulant and condiment; as a flavoring agent in salads, soups, sauces, tomato juice, pickles, and in the manufacture of celery salt.

**Average Dose.**—2 Gm. (30 grains).

**Celery Salt** is a mixture of finely ground celery fruit and free-running sodium chloride (table salt).

## ANGELICA FRUIT (ANGELICÆ FRUCTUS)

**Synonyms.**—*Angelica Seed*, *Ger.* Angelicasamen; *Fr.* Semence d' angélique.

**Botanical Origin.**—*Angelica Archangelica* Linné and other species of *Angelica*.



FIG. 313.—*Angelica atropurpurea* L. Upper portion of stem showing three compound umbels (above) and twice pinnately-compound leaf (below).  $\times \frac{1}{3}$ .

**Part Used.**—The dried ripe fruit.

**Habitat.**—Northern Europe and Siberia.

**Plant.**—*Angelica Archangelica* is a perennial herb with smooth, purple-green, hollow stems, twice pinnate leaves and greenish-white flowers.

**Production and Commerce.**—Angelica may be grown from seed which is best previously stored in moist sand several weeks before planting in the field. The seeds are sown in rows 12 in. apart with a distance of 2 ft. between the rows. Cultivation is necessary. The fruits are harvested in autumn, the roots in April. The rhizome and roots should be gathered from one year old plants. Both fruits and roots should be stored against attack by insects. Angelica fruit has been imported in bags from Belgium, Germany, Netherlands, and England. In 1946, 61,192 pounds of angelica seed and root were imported into this country.

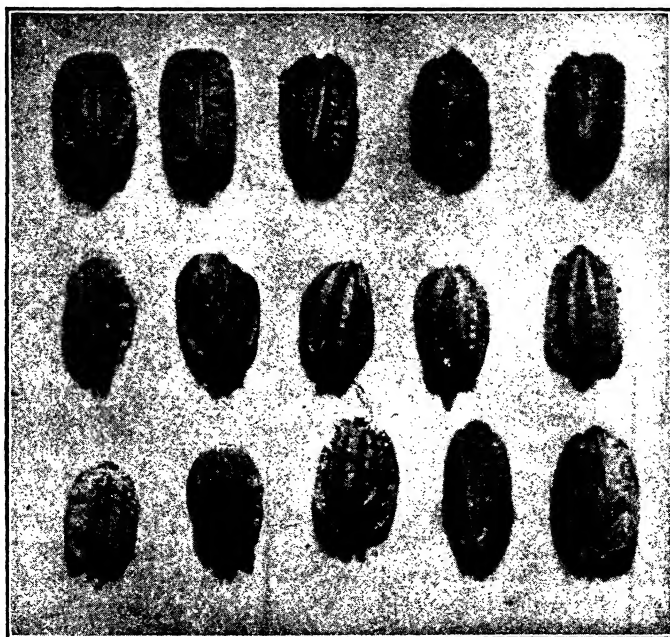


FIG. 314.—Angelica Fruit,  $\times 3$ .

**Description.**—Cremocarps oval, externally greenish-yellow or pale yellowish-brown, from 4 to 10 mm. in length, 3 to 6 mm. in breadth and from 1 to 2.5 mm. in thickness, the summit bearing five minute calyx teeth and the remains of a style; the two mericarps joined by their broad commissural faces or separate; each mericarp nearly flat upon the commissural surface, which bears a central longitudinal groove and has sharp, slightly upturned margins, convex upon the dorsal surface which shows 3 strong ribs, separated from one another by narrow grooves and from the margin by broad grooves; pericarp soft, rather tough and corky showing on cross section from 10 to 30 vittæ, and enclosing a single albuminous seed; odor characteristic; taste aromatic, sweetish and pungent.

**Constituents.**—*Volatile oil* (about 1 per cent.) containing a *terpene* with a pepper odor, *phellandrene* and *cymol*; bitter principle, angelic acid, resin, sugar, etc.

**Uses.**—Stimulant, aromatic, carminative, and ingredient in the formerly official Warburg's pills and tinctures.

**Average Dose.**—1 Gm. (15 grains).

#### CONIUM (CONIUM)

**Synonyms.**—Poison Hemlock, Spotted Hemlock, Snakeweed, Cowbane; *Fr.* Grand Ciguë; *Ger.* Schierling.

**Botanical Origin.**—*Conium maculatum* Linné.

**Part Used.**—The dried full grown, but unripe fruit.

**Purity Rubric.**—Not more than 2 per cent. of foreign fruits, seeds, or other foreign organic matter. It yields not less than 0.5 per cent. of coniine.

**Habitat.**—Europe and Asia. Naturalized in North and South America.

**Plant.**—A large, branching, poisonous, biennial herb found growing in waste places. Its stems are spotted and attain a height of from .6 to 2 m. Its leaves are large and decompose with lanceolate-pinnatifid leaflets which are dark green above and glossy beneath. The flowers are white and appear in mid-summer in long peduncled compound umbels. The poisonous juice of this plant was employed by the ancient Greeks as a potion which was given at the Athenian prison to criminals and philosophers as capital punishment. Socrates, Phœcion and other literary celebrities were put to death by this means. The herb has been employed as a drug in Europe where it has occasionally been adulterated with *Aethusa cynapium*.

**Production and Commerce.**—In North America, Poison Hemlock occurs wild, in waste places, from Canada to Indiana, California, Utah and Mexico. The fruits are collected from wild plants of the second year's growth while green, but full grown, screened, and dried with little exposure to light. They should be carefully stored in air-tight, light-proof containers. After having been kept for more than two years, Conium is unfit for use. The commercial supply of this drug is largely obtained from Europe.

**Description.**—Cremocarp ovoid, greenish-gray, the 2 mericarps of most of the fruits separated, each about 3 mm. in length, and about 1.5 mm. in diameter, ovoid, somewhat curved, the inner flattened side marked by a deep longitudinal groove, the outer convex side with 5, pale yellow, somewhat crenate ribs; pericarp without oil tubes (vittæ); odor slight, but when triturated with potassium hydroxide solution, strong, disagreeable, and mouse-urine like; taste characteristic, disagreeable, afterwards acrid. [See Fig. 305(4).]

**Histology.**—Transverse sections of the mericarp exhibit a pentangular outline, the angles projecting and forming the ribs, four of the sides being almost equal in length, the fifth or commissural side being about twice as long as one of the dorsal sides and usually concave near the middle; a distinct fibro-vascular bundle at each angle composed of thick-walled fibers about  $13\mu$  in diameter and a few tracheæ; epidermis consisting of one layer of cells which are sometimes slightly centrifugally developed, hairs are absent; pericarp thin, *without vittæ*, enclosing a single seed and extending inwardly on the commissural side for about one-third the diameter of the section; the inner epidermis of the pericarp

composed of two layers of cells with yellowish-brown walls, the outer layer with cells from  $6\mu$  to  $14\mu$  in tangential length and with thickened radial and inner walls, the inner layer with thin-walled cells from  $30$  to  $60\mu$  in tangential length and about  $30\mu$  in radial diameter; the seed coat composed of small, thick-walled cells about  $150\mu$  in radial diameter; often obliterated; a large endosperm or central portion being somewhat pentangular-rounded in outline, with a deep channel on the commissural side and composed of polygonal parenchyma cells;

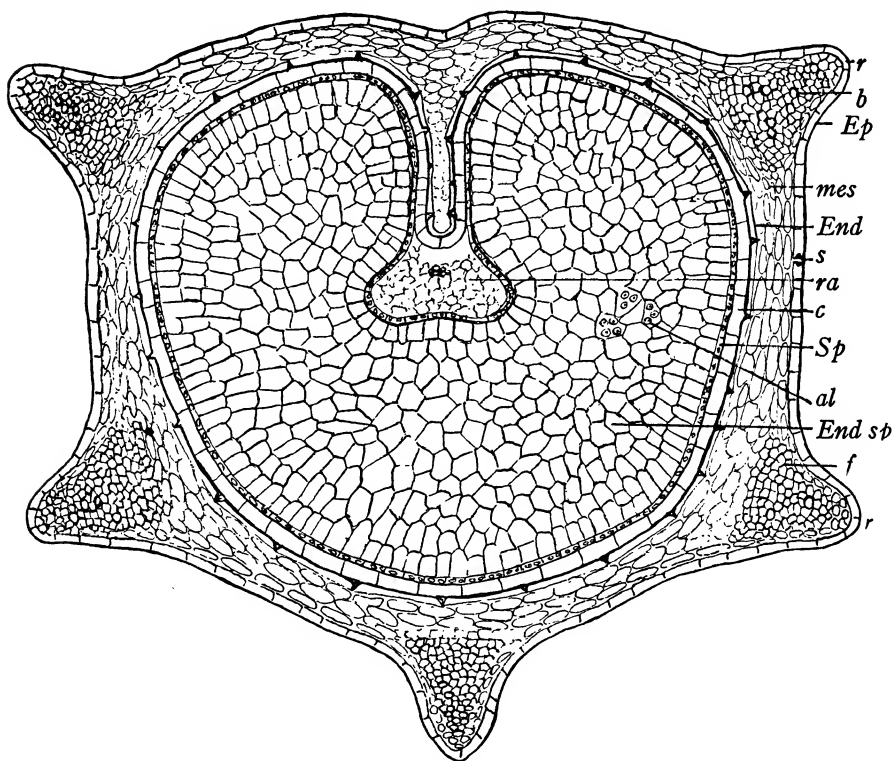


FIG. 315.—Conium. Transverse section of mericarp. *r*, rib; *b*, fibrovascular bundle; *Ep*, epicarp; *mes*, mesocarp; *End*, endocarp; *c*, clear layer of cells containing coniine; *Sp*, spermoderm; *End. sp*, endosperm; *al*, aleurone grains in endosperm cell; *s*, stoma; *f*, fibers; *ra*, raphe. Vittæ are absent in this drug.

the latter contain globules of fixed oil and aleurone grains with rosette aggregates of calcium oxalate, the latter up to  $8\mu$  in diameter.

**Powdered Drug.**—Greenish-gray. Numerous light colored fragments of endosperm tissue, composed of parenchyma cells containing aleurone grains, fixed oil and rosette aggregates of calcium oxalate, the latter up to  $8\mu$  in diameter; a few somewhat curved groups of long, thin-walled, lignified fibers; fragments of the seed coat with yellowish brown walls; few spheroidal starch grains up to  $5\mu$  in diameter; fragments of chlorophyll- and starch-parenchyma; numerous oil globules which separate on mounting powder in chloral hydrate solution.

**Constituents.**—Up to 3 per cent. of the poisonous liquid alkaloid, *coniine*; the solid and volatilizable, poisonous alkaloids, methylconiine, conydrine, pseudoconydrine, conicine; fixed oil, calcium oxalate, etc. Coniine acts on the peripheral ganglia similarly to nicotine.

**Conium Poisoning.**—The fruits, leaves and roots of *Conium maculatum* are poisonous, acting as a paralyzant to the motor areas of the brain and spinal cord and, in sufficient dosage producing paralysis of the voluntary muscles. The symptoms are a burning and smarting sensation in the mouth and throat, headache, muscular weakness and twitching, dilated pupils. At times, delirium, stupor, coma and convulsions occur. The effects are chiefly on the spinal cord. It first paralyzes the lower limbs, afterwards the arms and chest, producing death by paralyzing the muscles of respiration. Treatment consists of washing out the stomach with a watery solution of tannin, administration of an emetic (either 20 grains of zinc sulfate or 2 dr. of mustard, in water), hypodermic injections of morphine and maintaining respiration. Artificial respiration should be administered, if patient shows signs of asphyxiation.

**Uses.**—Conium is employed as a motor depressant and anodyne in tetanus, convulsions, delirium tremens, spasmodic chorea, paralysis agitans, etc.

**Average Dose.**—0.2 Gm. (3 grains).

**Preparation** (unof.).—Extractum Conii, 30 mg. ( $\frac{1}{2}$  grain).

#### CICUTA MACULATA (WATER HEMLOCK)

**Synonyms.**—Cowbane, Musquash, American Water Hemlock.

**Plant.**—A perennial herb, which grows in moist situations throughout North America. It is 2 to 6 feet tall and bears large compound umbels of white flowers and ellipsoidal fruits with large oil tubes. Lower leaves, 2 to 3 times pinnate; upper leaves smaller; all with long petioles sheathing the stem at their insertion.

The leaflets are lanceolate to oblong-lanceolate and coarsely serrate. The short, erect, bulbous rhizome has many cross partitions closely approximated as can be observed by cutting it through the center. Around its base are smaller roots appearing like small sweet potatoes. The roots have a parsnip-like odor and have been occasionally eaten by children.

**Constituents.**—*Cicutoxin*, a resin-like neutral principle soluble in alcohol. A very small quantity will cause death.

**Cicuta Poisoning.**—Soon after eating a severe abdominal pain occurs followed by nausea and vomiting. There is great mental excitement developing into a frenzy, often with frothing at mouth. Respiration is labored and irregular. Pulse intermittent. Convulsions follow and death ensues in from 15 minutes to 2 or 3 hours. Treatment consists in emptying the stomach, the administration of a barbiturate, as a physiological antagonist, stimulants to combat collapse, and morphine to control vomiting and reduce nervous symptoms and frenzy.



FIG. 316.—The American Water Hemlock, *Cicuta maculata* L. Plants and parts of plants in varying stages of development.  $\times \frac{1}{2}$ . Note the twice pinnate leaves, serrate leaflets, the lower leaves with long petioles, and the cluster of tubers at the base of the stem which is purple-streaked.

## CORIANDER N.F. (CORIANDRUM)

**Synonyms.**—*Coriander-seed*, Coliander; *Ger.* Koriandersamen; *Fr.* Coriandre.

**Botanical Origin.**—*Coriandrum sativum* Linné.



FIG. 317.—*Coriandrum sativum* L., the source of Coriander seed and oil.  $\times \frac{1}{2}$ .

**Part Used.**—The dried ripe fruit.

**Standard of Assay.**—It yields not less than 0.25 cc. of volatile coriander oil from each 100 Gm. of drug.



**Limit of Impurities.**—Not more than 5 per cent. of foreign organic matter. It yields not more than 1.5 per cent. of acid insoluble ash.

**Ash.**—Not more than 7 per cent. of total ash, nor more than 1.5 per cent. of ash insoluble in hydrochloric acid (S.R.A., F.D., U.S. Dep. Agr., Nov., 1936).

**Habitat.**—Mediterranean and Caucasian regions. Naturalized in the United States.

**Plant.**—An annual fetid smelling herb with erect, slender, smooth stem, branched in the upper part. The lower leaves are long-petioled, pinnate with nearly sessile, ovate to sub-orbicular, deeply lobed leaflets, crenate-dentate on margin; upper leaves nearly sessile, bi- or tri-pinnate with ultimate segments

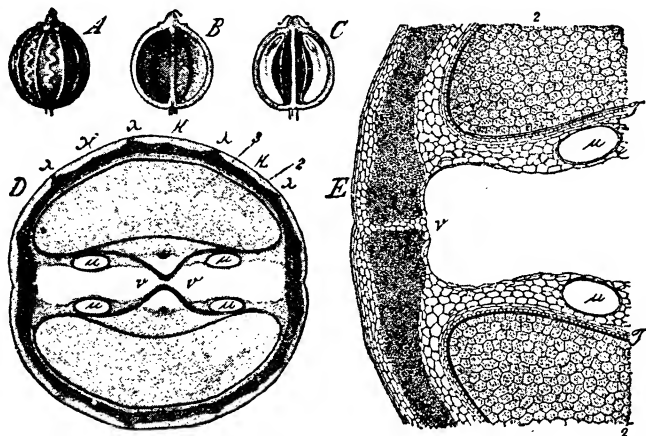


FIG. 318.—Coriander. A, whole fruit (cremocarp),  $\times 3$ ; B, commissural surface of half fruit (mericarp), showing the vittæ as dark lines; C, longitudinal section through both mericarps showing the endosperm and embryo,  $\times 3$ ; D, transverse section of cremocarp showing the vittæ ( $\mu$ ) magnified  $\times 14$ ; E, portion of same, further enlarged;  $\kappa$ , primary ribs (ridges);  $\lambda$ , secondary ribs; 2, endosperm. (From Greenish, after Berg.)

strap-shaped or linear. The inflorescences are compound umbels of white or pink flowers. No involucre is present. The fruit is a nearly spherical cremocarp.

**Production and Commerce.**—Coriander grows wild in southern Europe and Asia Minor and is cultivated there as well as in India, northern Africa, South and Central America and the United States. The State of Kentucky has produced considerable of the American crop. The plants are propagated from seeds which are sown thickly in fertile garden soil, in the spring. The rows should be from  $1\frac{1}{2}$  to 3 feet apart for cultivation purposes. When sufficiently strong, the plants are thinned to stand about 5 inches apart in the row. The plants are mowed down when most of the fruits are ripe, partially cured in the field and dried under cover. The fruits are then thrashed out and cleaned. They are subject to insect attack and should be stored in air-tight containers into which carbon tetrachloride or chloroform is introduced (4 cc. per cu. ft.) upon storage and again within 2 weeks.

Most of the drug used in the United States is imported in bags from French

Morocco, Mexico, Peru, Guatemala, Argentina, Italy, Hungary, Iran, Malta, India and Russia. During 1947, 1,824,587 lbs. were imported.

**Description.**—Mericarps usually coherent; cremocarp nearly globular, from 2 to 5 mm. in diameter; externally weak yellowish orange to moderate yellowish brown, frequently with a purplish red blush; summit with 5 calyx teeth and a short stylopodium, each mericarp with 5 prominent, straight, longitudinal primary ribs and 4 undulate secondary ribs; mericarps easily separated, deeply concave on the commissural or inner surface and showing, in transverse section, 2 vittæ in the mesocarp of the commissural side of each; odor fragrant; taste pleasantly and characteristically aromatic.

**Histology.**—Transverse sections of each of the component mericarps show the following microscopical peculiarities:

1. *Epicarp* consisting of a layer of small, thick-walled epidermal cells.
2. *Mesocarp* of several rows of thin-walled, somewhat collapsed parenchyma, separated from a broad continuous zone of thick-walled, strongly lignified *sclerenchyma fibers*; two or three rows of large, thin-walled parenchyma containing prominent intercellular-air-spaces. Imbedded in this zone on the commissural side are two large elliptical vittæ.
3. *Endocarp*, of a layer of large tabular cells with thick, yellowish inner walls, adherent to the darker cells of the seed coat, except on the commissural side, where a large elliptical cavity occurs, separating this layer from the spermoderm.
4. *Spermoderm* or seed coat of tangentially-elongated, brownish cells.
5. *Endosperm*, of reniform outline and consisting of polygonal, thick-walled cells containing numerous large aleurone grains and globules of fixed oil. Each aleurone grain contains a rosette aggregate or prism of calcium oxalate from 3 to 10 $\mu$  in diameter.
6. *Embryo*, enveloped by endosperm in the upper end of the seed.

**Powdered Drug.**—Moderate yellowish brown; consisting chiefly of fragments of endosperm and lignified pericarp tissues; sclerenchyma fibers irregularly curved having thick, yellow lignified walls and many simple pores; few fragments of light yellow vittæ; numerous calcium oxalate crystals from 3 to 10 $\mu$  in diameter, mostly in rosette aggregates, either isolated or in aleurone grains; numerous globules of fixed oil; fragments of epicarp with elongated, polygonal, epidermal cells, at times associated with an underlying vitta.

**Constituents.**—Up to 1 per cent. of *volatile oil* containing *coriandrol* (*d*-linalool) and *d*-pinene, etc.; fixed oil, calcium oxalate, and tannin.

**Uses.**—Aromatic stimulant, corrective of purgative preparations and source of oil of coriander U.S.P., condiment in bread, cake and pastry, and flavoring agent in cordials, confectionery and tobacco.

**Average Dose.**—2 Gm. (30 grains); of coriander oil, 0.1 cc. (1½ minims).

**Preparation.**—Infusum Gentianæ Compositum, N.F. VII, 15 cc. (4 fl. dr.).

**Allied Drug.**—Bombay Coriander consists of the dried fruit of a variety of the same plant. The fruits are oval and contain less volatile oil than the official article.

**Coriander Oil** (*Oleum Coriandri*) U.S.P. is the volatile oil distilled with steam from the dried ripe fruit of *Coriandrum sativum*. It is colorless to pale yellow with a sp. gr. of 0.863 to 0.875 at 25°C. and an optical rotation of +8° to +15° in a 100 mm. tube at 25°C. Stimulant and flavoring agent. U.S.P. Preparations: Compound Orange Spirit, Aromatic Elixir (from Spt. Aur. Co.); Senna Syrup, 8 cc.; Aromatic Cascara Sagrada Fluidextract, 2 cc.

#### PARSLEY FRUIT (PETROSELINUM)

**Synonyms.**—Parsley Seed, Common or Garden Parsley; *Ger.* Petersilie; *Fr.* Persil.

**Botanical Origin.**—*Petroselinum crispum* (Mill.) Nyman (*Petroselinum sativum* Hoffman).

**Part Used.**—The dried ripe fruit.

**Habitat.**—Mediterranean Region.

**Plant.**—An aromatic biennial herb with ternately pinnate, decompound leaves, the leaflets being small, ovate, 3 cleft and toothed. The flowers are yellow and borne on compound umbels showing many parted involucels.

**Production and Commerce.**—Parsley has been cultivated on a large scale in United States and Europe for its fruit, leaves and root which are employed for culinary purposes as well as in medicine. It is grown on an extensive scale in Louisiana. The plants thrive best in a rich moist soil with a certain amount of shade. The plants are propagated from seeds (fruits) which are sown in early spring in cold frames. The seedlings, when 2 or 3 inches tall are transferred to the garden or field, where they are planted about 6 inches apart in rows about a foot apart.

The fruits are gathered the second year when ripe and carefully dried. The leaves may be gathered when full grown from both first and second year plants. They constitute a rich source of Vitamin C. The root is dug up at the end of the second growing season in October, the thicker roots cut longitudinally to facilitate drying and all well washed and carefully dried by artificial heat. The Hamburg or turnip-rooted variety is preferred for the root.

**Description.**—Cremocarp ovate; mericarps usually separated, crescent shaped, from 2 to 3 mm. in length and about 1 mm. in diameter; externally grayish to grayish-brown showing 5 yellowish primary ribs alternating with roughened furrows; nearly hemispherical in transverse section, there being 2 vittæ in the commissural and 1 to 2 vittæ between each of the primary ribs in the dorsal region of the fruit wall; endosperm large, oily, enclosing a small embryo near summit of seed; odor and taste characteristically aromatic, the odor being most pronounced when the fruit is bruised.

**Constituents.**—Up to 7 per cent. of *volatile oil* containing *apiol* (parsley camphor), myristicin and a terpene; resin, *apiin*, fixed oil, mucilage, etc.

**Use.**—Emmenagogue in amenorrhœa and dysmenorrhœa, stimulant and diuretic; condiment.

**Parsley Leaf or Dried Parsley** is employed in the culinary art for flavoring soups, meats and fish, salads, sauces and in garnishing. It occurs in the entire, rubbed or ground form. Its chief constituents are *Vitamin C* and *volatile oil*.

**Average Dose.**—1 Gm. (15 grains).

**Apiol** ( $C_{12}H_{14}O_4$ ) is the di-methoxy-methylene ether of allyl-tetraoxybenzene. It occurs in its pure form as white crystals melting at  $30^{\circ}C.$ , having a



FIG. 319.—Dill (*Anethum graveolens*).

faint parsley odor, insoluble in water, soluble in ether, alcohol and fixed oils. It is obtained from oil of parsley (parsley apiol) and from varieties of oil of dill (dill apiol). **Liquid apiol** consists of oleoresin of parsley fruit made by percolating the fruit with ether. The latter has been used in dysmenorrhea and other uterine disorders in doses of 5 to 10 minims. It contains apiol, white apiolin and myristicin which slow the pulse and lower blood pressure.

## ANETHI FRUCTUS (DILL FRUIT)

**Synonyms.**—Garden Dill, Dill Seed, Anet; *Ger.* Dill; *Fr.* Fenouil puant.

**Botanical Origin.**—*Anethum graveolens* L. (*Peucedanum graveolens* Benth. and Hooker filius).

**Part Used.**—The dried ripe fruit.

**Habitat.**—Southern Europe.

**Plant.**—An annual herb with a branching, green stem up to 4 ft., with tripinnate leaves with linear leaflets and yellow flowers arranged upon compound umbels.

**Production.**—Dill is cultivated in England, Germany, Roumania, India, and United States for its leafy stems which are used as an aromatic flavor for pickles and soups and for its fruits. The commercial supplies prior to World War II were largely imported from England and Germany. Michigan and Wisconsin have recently been producing considerable of the domestic supply of dill fruits.

**Culture.**—The seed is sown in rich loam in early spring or late autumn, it being drilled in rows 2 to 3 ft. apart. The plants are later thinned in the rows to stand 12 to 15 in. apart. For the seed crop, the plants are mowed when the earliest seeds are ripe and the harvested material dried in cocks in the field or under cover in the outbuilding. The seed is then threshed out and cleaned. When grown for the production of dill oil, the crop should not be cut until the seeds are turning brown. The overground plants are then partially dried and distilled with steam. Dill oil is used for flavoring some dill pickles in place of the herb.

**Description.**—Mericarps usually separate and free from pedicel, each brown, glabrous, broadly oval, compressed, about 4 mm. long and 2.5 mm. broad, 5-ribbed, the 3 dorsal being brown and much shorter than the 2 lateral ribs which are yellowish and wing-like; odor and taste characteristically aromatic.

**Constituents.**—*Volatile* oil containing *carvone*, *limonene* and *terpenes*.

**Uses.**—Stimulant, aromatic and carminative; in the flavoring of dill pickles, salads, meat and fish sauces, soups, etc. The ground spice is an ingredient in meat seasoning preparations.

**Average Dose.**—2 Gm. (30 grains).

## ANGELICÆ RADIX (ANGELICA ROOT)

**Synonyms.**—Archangel Root, Holy Ghost Root. *Ger.* Angelikawurzel, Erzengelwurzel; *Fr.* Racine d'angélique, Racine du St. Esprit.

**Botanical Origin.**—*Angelica Archangelia* Linné and other species of *Angelica*.

**Part Used.**—The dried rhizome and roots.

**Habitat and Plants.**—See *Angelicæ Fructus*.

**Production and Commerce.**—The plants are cultivated in northern Europe. The rhizomes and roots are dug up in autumn, cleaned, the thicker rhizomes cut into longitudinal slices and carefully dried. The commercial supplies reach this country through Belgium.

**Description.**—Rhizomes vertical, short and thick, 5 to 10 cm. long, sometimes split, upper portion frequently crowned with leaf and stem bases; roots,

## DISTINCTIONS BETWEEN IMPORTANT UMBELLIFEROUS FRUITS

	Anisum	Carum	Conium	Coriandrum	Feniculum	Petroselinum
Synonym	✓ Anise seed	✓ Caraway seed	Poison hemlock	✓ Coriander seed	✓ Fennel seed	Parsley seed
Botanical origin	Pimpinella Anisum	Carum carvi	Conium maculatum	Coriandrum sativum	Foeniculum vulgare	Petroselinum crispum
Habitat	Asia Minor, Egypt, and Greece	Europe, Asia	Europe	Mediterranean Basin	Europe and Asia	So. Europe and Asia Minor
Plant	Annual herb	Biennial herb	Biennial herb	Annual herb	Perennial herb	Biennial herb
Occurrence	Entire cremocarps with few mericarps; pedicel adhering	Mericarps usually separated	Mericarps usually separated	Entire cremocarps generally	Mericarps usually separated	Mericarps usually separated
Vittæ in mesocarp of each mericarp	2 on commissural side; 15-45 on dorsal side	2 vittæ on commissural side; a vitta between each 2 primary ribs on dorsal side	None present	2 vittæ on commissural side; none on dorsal side	2 occasionally 4 vittæ on commissural side; one vitta between each 2 primary ribs on dorsal side	2 vittæ on commissural side; one vitta between each 2 primary ribs on dorsal side
Hairs	Numerous unicellular; non-glandular hairs present	Absent	Absent	Absent	Absent	Absent
Constituents	Volatile oil containing anethol	Volatile oil containing carvol	The liquid alkaloid, coniine; conydrine	Volatile oil containing coriandrol	Volatile oil containing anethol, fenchone	Volatile oil containing apiol, and a terpene; resin, etc.
Adulterants	Conium	Cumin Ergotized Caraway Aegopodium	Aethusa	Bombay or Indian Coriander	Roman fennel, wheat, Bitter fennel, Meum	Weed seeds

fleshy, up to 20 cm. long and from 5 to 7 mm. thick at the base and gradually tapering to about 1 mm., frequently twisted and braided together and attached to rhizome; externally dark gray brown to reddish- and purplish-brown, deeply furrowed; fracture short and smooth; internally light and yellow with a spongy bark showing radial rows of brownish oleoresin reservoirs, a broad radiate and porous wood, and a pith in the rhizome; odor aromatic; taste sweetish, pungent, aromatic and bitter.

**Constituents.**—Up to 1 per cent. of *volatile oil* containing a terpene with a pepper-like odor, phellandrene and cymol; resin, a bitter principle, angelic acid, valeric acid, tannin, starch, etc.

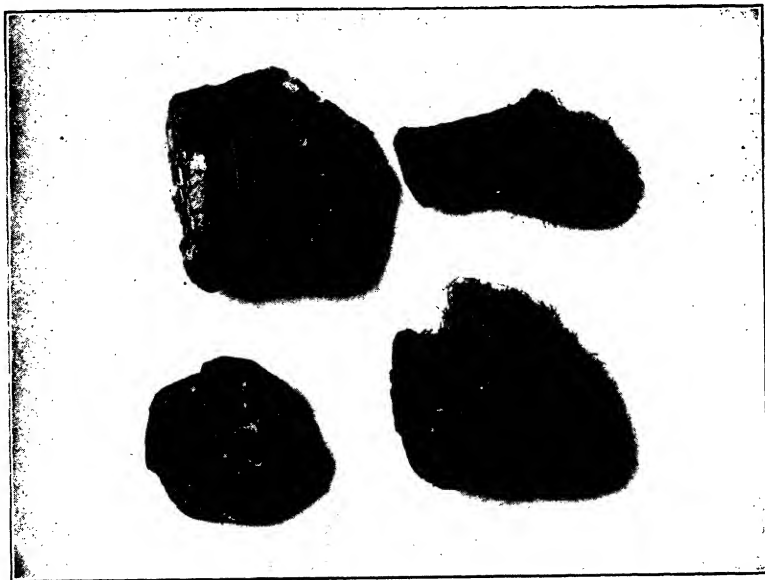


FIG. 320.—Sumbul,  $\times \frac{1}{2}$ . (Photograph by W. J. Stoneback.)

**Uses.**—Aromatic bitter and carminative.

**Average Dose.**—2 Gm. (30 grains).

**Allied Drug.**—**Levisticum or Lovage** (*Radix Levistici*, *Liebstockelwurz* Ger. Ph.) represents the dried rhizome and roots of *Levisticum officinale* Koch (Fam. *Umbelliferae*), a tall perennial herb with a vertical rhizome bipinnate cauline leaves, greenish yellow flowers and ovate-oblong, flattened cremocarps. It is native to Southern Europe and extensively cultivated in Germany. The rhizome is light grayish brown, annulated, up to 4 cm. in diameter with scars from leaf remains at the apex. The roots are up to 5 mm. in diameter, deeply longitudinally wrinkled. The fracture of both rhizome and roots is short and their texture spongy, the fractured surface of the rhizome showing a thick bark with numerous radially-arranged schizogenous oleoresin reservoirs with brown or reddish yellow contents, a narrower, yellow porous wood and a white pith. The odor is characteristically aromatic, the taste aromatic, sweet, pungent and

bitter. It is used as a stimulant, aromatic, carminative, diuretic and diaphoretic. Average dose, 2 Gm. (30 Grains), usually in decoction.

### SUMBUL (SUMBUL)

**Sumbul or Musk Root** consists of the dried rhizome and roots of *Ferula Sumbul* (Kauffmann) Hooker filius or other related species of *Ferula* possessing a characteristic musk-like odor. The plants yielding Sumbul are perennial herbs native to Asia. The commercial supplies of the drug are obtained from Turkey and Russia. Musk root contains volatile oil, resinous matter including a white resin which, on hydrolysis, yields vanillic acid, a bitter principle, umbelliferone, valeric, methyl crotonic and angelic acids, starch, etc. It has been used as a calmative in hysteria and some other nervous disorders. **Average Dose**, 30 grains. **Preparation**, Sumbul Extract, 0.5 Gm. (8 grains). A spurious substitute for Sumbul has recently been offered on the American market. It was found to represent the rhizome of *Nardostachys Jatamansii* (Fam. *Valerianaceæ*), native to India.

### ASAFETIDA N.F. (ASAFETIDA)

**Synonyms.**—*Gum Asafetida*, Devil's Dung, Food of the Gods; *Ger.* Teufels-dreck, Stinkasant; *Fr.* Assefétide.

**Botanical Origin.**—*Ferula fætida* Regel, *Ferula Assa-fætida* Linné and some other species of *Ferula*.

**Part Used.**—The oleogum-resin obtained by incising the living rhizomes and roots.<sup>11</sup>

**Standard of Assay.**—Not less than 50 per cent. of alcohol-soluble extractive.

**Limit of Impurities.**—Not more than 15 per cent. of acid-insoluble ash.

**Habitat.**—Persia and Afghanistan.

**Plants.**—Perennial monococious herbs, each with a conical erect rhizome, furrowed but smooth, green, succulent stem attaining a height of about 3 dm., and ternately compound leaves. The inflorescences are compound umbels of yellow flowers. The fruit is a cremocarp.

**Collection and Commerce.**—Several species of *Ferula* yield Asafoetida, especially *F. Assa-foetida*, *F. foetida* and *F. rubricaulis* Boiss. In spring of the year, the stems of the Asafoetida yielding plants are cut down and a slice cut off the crown of each rhizome, when a milky juice exudes. The exposed surface is then covered with a dome-shaped structure made of twigs and earth to protect the exudate from the heat of the sun. About a month later the collectors return and find a thick, reddish, gummy exudate which they scrape off and place in leather bags. Collection is repeated at intervals of 10 days until exudation ceases. The product obtained from numerous plants is mixed and allowed to harden in the sun. Most of the drug is collected in Eastern Persia and Afghanistan. It is sent to the main trade centers, Herat and Kandahar, from whence it is shipped to dealers in various European and Asiatic countries. During 1947, 80,423 lbs. of Asafoetida were imported from Iran and India. It comes in mats, cases or casks.



**Description.**—This drug generally occurs as irregular hard or soft masses or as tears, occasionally as an almost semi-liquid mass, usually admixed with vegetable fragments; when in mass form, the tears imbedded in a weak brown to moderate yellowish-brown matrix. Tears ovoid from 1 to 4 cm. in diameter, the surface sometimes showing streaks of violet, yellowish-red or brownish-red and with a few vegetable fragments; the freshly fractured surface being milky-white or moderate yellowish-brown changing gradually on exposure to air or light to a strong pink and finally to a moderate yellowish-brown; upon moistening with water the tears become moderate orange to weak yellow; odor garlic-like and persistent; taste bitter, garlic-like and acrid. When triturated with water, it forms a yellowish-orange emulsion, which becomes greenish-yellow on the addition of alkaline solutions. An alcoholic solution of the drug acquires a cherry-red color upon the addition of solution of phloroglucin and hydrochloric acid. When a fragment of *Asafetida* is heated with  $H_2SO_4$ , a reddish-brown solution is formed. When this solution is greatly diluted with water, filtered and made alkaline, it acquires a purplish-blue fluorescence.

**Powdered Drug.**—This is prepared by drying the crude article over freshly burnt lime or by currents of warm air (air at about  $30^{\circ}C.$ ) until it ceases to lose weight and then comminuting it at low temperatures. The use of diluents of starch or magnesium carbonate are necessary in order to maintain it in powdered form.

**Adulterants.**—1. *Galbanum*, a gum resin obtained from *Ferula galbaniflua*, a perennial herb growing in Persia and Afghanistan. It may be detected in *Asafoetida* by breaking suspected tears and touching the freshly fractured surface with nitric acid diluted with an equal volume of water, when a green color develops. If to 10 cc. of an alcoholic extract of the sample, sufficient  $HCl$  is added to induce a faint turbidity, a bluish-green color which fades when the mixture stands indicates the presence of galbanum.

2. *Rosin*. If this be present, a petroleum benzin solution of the sample will give a bluish-green color on shaking it with a freshly made (1-20) solution of copper acetate.

3. *Ammoniac*, a gum resin obtained from *Dorema Ammoniacum*, a perennial herb, indigenous to Persia and Turkestan. The presence of *Ammoniac* is indicated when an aqueous emulsion of the suspected sample is colored red upon the addition of sodium hypobromite test solution.

4. Vegetable Tissues. 5. Gums. 6. Cereal flours. 7. Gypsum. 8. Pebbles. 9. Sand. 10. Marble.

**Constituents.**—About 60 per cent. of a reddish-brown resin consisting of *ferulaic acid* combined with *asaresinotannol*; from 3 to 10 per cent. of a *volatile oil* containing *hexenyl sulphide* and *disulphide*, *cadinene* and *pinene* to which the odor of the drug is due; *vanillin*, *ferulaic acid*, *formic*, *malic*, *acetic* and *valeric acids*, etc.

**Uses.**—Stimulant, carminative, nervine stimulant in hysteria, and laxative.

**Average Dose.**—0.4 Gm. (6 grains).

**Preparations.**—Asafetida Pills, N.F., 2 pills; Asafetida Tincture, N.F., 1 cc. (15 minims).

#### SUB-CLASS B.—SYNPETALÆ

Those dicotyledonous plants in which the flowers possess both calyx and corolla, the latter with petals more or less joined along their margins.

#### ERICACEÆ (HEATH FAMILY)

Sub-herbaceous (*Chimaphila* or Pipsissewa), suffruticose (*Erica* or Heath), fruticose (*Azalea*, *Rhododendron*, *Kalmia* or Mountain Laurel, etc.), rarely sub-arborescent (*Arbutus unedo* or Strawberry Tree) plants. Roots fibrous, often saprophytically associated, rarely tuberous or more or less enlarged. Stem upright, ascending or creeping, more or less woody, rarely through saprophytic connection becoming soft, annual and pale above ground (*Monotropa uniflora* or Indian Pipe). Leaves alternate, simple, entire, exstipulate, rarely soft, delicate, herbaceous (*Azaleas*), usually leathery to wiry and evergreen, more rarely (*Pterospora*, *Monotropa*, etc.) becoming greenish-blue, bluish-yellow, yellowish-white to white and correspondingly saprophytic. Inflorescence typically a raceme (*Pyrola*, *Andromeda*, *Gaylussacia* (Huckleberry), *Vaccinium* (Blueberry), *Erica*, *Arctostaphylos Uva Ursi*, etc.) but raceme condensed into a racemose umbel (*Azalea*, etc.) or further reduced to a few flowers or, in the degraded saprophytic condition, to one flower (*Monotropa uniflora*). Flowers regular, passing to irregular (*Rhododendron*), pentamerous or tetramerous; sepals five to four, rarely fewer, apo- to synsepalous, usually green, sometimes brightly petaloid; petals five, more rarely four, slightly to deeply synpetalous, cup-shaped (*Kalmia*) to urceolate (*Arctostaphylos*, *Andromeda*, etc.), yellow to white or through yellow pink to scarlet to crimson to crimson-purple; stamens ten to eight in two circles of five to four each, becoming by absorption of inner circle four only, hypogynous, epipetalous or epigynous; anthers two-celled, dehiscing by apical pores (*Arctostaphylos*) or apical slits; pollen sometimes agglutinated into long viscous threads; pistil five- to four-, rarely six- to eight-carpeled, superior, rarely semi-inferior to inferior (*Vaccinææ*); ovary as many celled as there are carpels; style elongated, filiform, usually five- to four-lobed. Fruit a capsule (*Trailing Arbutus*), berry (*Vaccinium*) or false drupe (*Gaultheria*). Seeds small, anatropous. Arbutin (ericolin) and ursone as well as tannin and gallic acid occur in a number of plants of this family.

#### UVA URSI N.F. (UVA URSI)

**Synonyms.**—Bearberry, Red Bearberry, Mountain Box, Rockberry; *Ger.* Bärentraubenblätter, *Fr.* Rasin d'ours.

**Botanical Origin.**—*Arctostaphylos Uva-ursi* (Linné) Sprengel, or its varieties *coactylis* and *adenotricha* Fernald and MacBride.

**Part Used.**—The dried leaf.

**Purity Rubric.**—Not more than 3.5 per cent. of the stems of the plant and not more than 2 per cent. of other foreign organic matter; it yields not more than 1.5 per cent. of acid-insoluble ash.

**Habitat.**—In gravelly or sandy soil of northern Europe, Asia and North America.

**Plants.**—Procumbent evergreen shrubs with trailing stems bearing short ascending branches which in turn bear leaves that have an ovate, ovate-spatulate

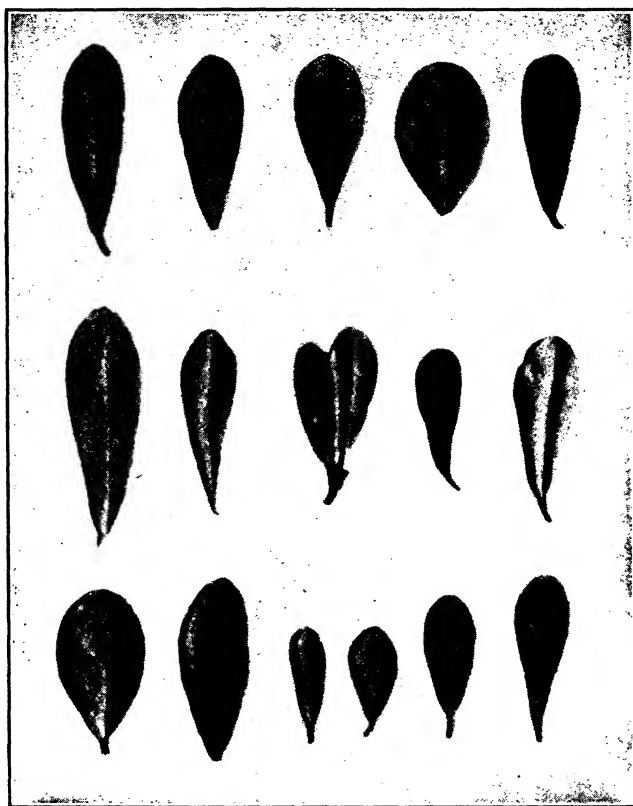


FIG. 321.—*Uva Ursi*. *Nat. size.*

to spatulate outline. The flowers are hypogynous and borne in small clusters at the ends of branches. Each flower consists of a calyx of 5 reddish sepals, a reddish-white urceolate corolla, gamopetalous but divided at the margin into 5 short reflexed segments, 10 short stamens with bifid anthers, and a syncarpous pistil of 5 carpels. The style portion of the pistil is simple and longer than the stamens. It ends in a knob-like stigma.

**Commercial.**—*Uva Ursi* leaves are gathered in autumn, only the green ones being picked. While considerable of the drug has been imported from Barcelona, Spain, much has been gathered for the market in California, the Northern states and Canada.

**Description.**—The drug occurs usually in an entire or nearly entire condition. Leaves short petiolate, the laminæ being obovate, oblong or spatulate, up to 30 mm. long and from 5 to 13 mm. broad, with obtuse or rounded summits, entire or slightly revolute margins and cuneate bases, olive-brown to olive, waxy, glabrous and finely reticulate on upper surface, glabrous (*A. Uva-ursi*), glistening, finely reticulate and yellowish green on lower surface; pubescent especially on mid-rib and petiole (var. *coactylis* and var. *adenotricha*); texture coriaceous, fracture short; odor slightly aromatic and tea-like; taste astringent and bitter.

**Powdered Drug.**—Dusky yellow to light olive. Numerous cells of the mesophyll with chloroplastids and frequently irregular masses of a carbohydrate; fragments of fibrovascular bundles showing spiral tracheæ and narrow lignified sclerenchyma fibers associated with which are crystal fibers containing monoclinic prisms of  $\text{CaO}$  up to  $30\mu$  in length; epidermis with polygonal cells and broadly elliptical stomata, the latter up to  $40\mu$  in length, surrounded by 5 to 8 radiate neighboring cells; pericyclic fibers lignified, of irregular shape with thick, porous, tuberculated walls and curved ends; hairs, unicellular, non-glandular, short, serpentine or straight, or with a 1- to 4-celled stalk and a small, 1-celled head (var. *adenotricha*); numerous fragments of cells having a yellowish-brown content which is colored a bluish-black with ferric chloride T.S. If a small quantity of the powder be placed in a watch crystal and covered with another watch crystal or microscopic slides and the powder gently heated, a crystalline sublimate of *hydroquinone* is formed consisting of long rods and feather-like aggregates and hexagonal plates colored reddish-brown with ammonia T.S. and light green with a solution of ferric salts. These give a brilliant play of colors in polarized light.

**Constituents.**—The glucoside *arbutin* (*ericolin*), a crystalline resinous substance called ursone; *tannic acid*, gallic acid, calcium oxalate, etc.

**Uses.**—Diuretic and mild disinfectant to urinary tract.

**Average Dose.**—2 Gm. (30 grains).

**Preparations.**—Uva Ursi Fluidextract, 2 cc. (30 minims).

#### CHIMAPHILA (CHIMAPHILA)

**Synonyms.**—Pipsissewa, Prince's Pine, Bitter Wintergreen, Ground Holly. *Fr.* Herbe de Pyrole ombellée; *Ger.* Doldenblüthiges Harnkraut.

**Botanical Origin.**—*Chimaphila umbellata* (Linné) Barton and its var. *cisatlantica* Blake.

**Part Used.**—The dried leaf.

**Purity Rubric.**—Not more than 5 per cent. of the stems of the plant or other foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—Northern America, Europe and Asia, in dry woods.

**Plant.**—A low perennial herb with long extended subterranean shoots sending up aerial stems which bear whorled and scattered cuneate-lanceolate, sharply serrate, coriaceous, shiny leaves and a terminal 2–8 flowered raceme of pinkish flowers, the anthers of which are violet colored. The fruit is a capsule.

**Commercial.**—The commercial supplies come largely from Virginin, North Carolina and Michigan.

**Description.**—This drug occurs as entire and broken leaves usually admixed with a few stems. Leaves, oblanceolate, 2.5 to 7 cm. in length and from 8 to 20 mm. in breadth, the distal portion coarsely and sharply serrate, acute or somewhat obtuse, the proximal wedge-shaped and nearly entire; coriaceous,



FIG. 322.—Pipsissewa (*Chimaphila umbellata*). Leaves and leafy stems.

smooth, shiny, and uniformly dark green to olive-brown on the ventral surface, paler beneath, the veins prominent; odor slight; taste astringent and bitter.

**Powdered Drug.**—Moderate yellowish brown to light olive. Fragments of epidermis composed of cells with clear, unevenly thickened, porous and wavy, vertical walls, those from the lower epidermis showing broadly elliptical stomata up to  $40\mu$  in length; fragments of mesophyll, some of the cells of which contain chloroplastids, others tannin; fragments of parenchyma containing a reddish brown to yellowish orange amorphous substance; fragments of the epidermis of

the stems, the cells of which contain a purplish pigment that is colored yellowish red with acids and green with alkalies; calcium oxalate in rosette aggregates up to  $65\mu$  in diameter; starch grains few, simple, spheroidal, up to  $16\mu$  in diameter or 2- to 4-compound; fragments of sclerenchyma fibers; tracheæ with spiral or annular thickenings; elongated, thick-walled, lignified cells showing minute reticulations.

**Constituents.**—The glucoside *arbutin* (*ericolin*); a neutral principle, *chima-philin*; tannin, gallic acid, etc. Arbutin is resolved by hydrolysis into dextrose and hydroquinone.

**Uses.**—Chimaphila is used as a diuretic, astringent and mild disinfectant to urinary tract; in cystitis, gonorrhœa, etc.

**Average Dose.**—2 Gm. (30 grains).

**Allied Plant.**—*Chimaphila maculata* or Spotted Wintergreen is a perennial herb growing in North America frequently in localities where Pipsissewa abounds. Its leaves are lanceolate or ovate-lanceolate, obtuse at the base, toothed, the upper surface spotted with white. It has occasionally been found as an adulterant of Chimaphila.

#### GAULTHERIA OIL (OLEUM GAULTHERIÆ)

**Official Title.**—Methyl Salicylate.

**Synonyms.**—Oil of Teaberry, Oil of Checkerberry, Natural Oil of Wintergreen; *Ger.* Wintergrünöl; *Fr.* Essence de Gaultheria.

**Botanical Origin.**—*Gaultheria procumbens* Linné.

**Part Used.**—The volatile oil obtained by distillation from the leaves or plants.

**Habitat.**—Eastern North America.

**Plant.**—A low, procumbent, evergreen shrub with slender creeping stems from which arise erect branches attaining a height of 15 cm. that bear toward their ends 3 to 8 alternate, dark green, obovate to oval leaves which possess a nearly glabrous surface, a mucronate apex, and a slightly revolute and serrate margin, a characteristic sweet-birch odor and a distinctly aromatic and astringent taste. The flowers are white, urceolate, and nodding in the leaf axils. The fruit is a 5-celled capsule enclosed within a fleshy, bright red calyx.

**Production and Commerce.**—The oil of wintergreen industry has as its present center the mountainous sections of Pennsylvania, although smaller quantities are also produced in New Jersey, New York, Maryland and West Virginia. While the best raw material consists of green leaves harvested in September, oil is also obtained from leafy stems and entire plants.

The oil is only formed after the enzyme gaultherase acts upon the glycoside gaultherin in the presence of water. Commercially, the oil is produced by chopping up the green leaves or plants, moistening with water, and placing these in the retort of a copper still or improvised charred oak barrel with a perforated bottom where the moistened material is covered with water, kept at a temperature of  $120^{\circ}\text{F.}$ , and macerated over night. The perforated bottom

fits tightly over a water-filled kettle, and the upper end of the barrel is connected by means of a copper helmet with a spiral condenser. In the morning a fire is built beneath the retort and distillation proceeds. The heavy oil is collected in flasks and the aqueous distillate transferred to the still for a second charge. The crude oil is purified by rectification. The yield of oil varies from 0.5 to 0.8 per cent. The red color of some samples is generally believed to be due to a trace of iron taken up by the oil during its manufacture.

**Description.**—A colorless, yellowish or reddish liquid possessing a characteristic strongly aromatic gaultheria odor and taste, slightly laevorotatory (in contrast to oil of betula and synthetic methyl salicylate which are optically



FIG. 323.—Wintergreen (*Gaultheria procumbens*).  $\times \frac{1}{2}$ .

inactive); soluble in about 7 volumes of 70 per cent. alcohol at 25°C. with not more than a slight cloudiness; sp. gr. 1.176 to 1.182.

**Constituents.**—About 99 per cent. of *methyl salicylate*, the remainder consisting of a paraffin called triacontane, an aldehyde, an alcohol and an ester.

**Uses.**—Oil of wintergreen as well as oil of sweet birch and synthetic methyl salicylate are used as stimulant, rubefacient, antirheumatic and flavoring agents.

**Adulterants.**—Petroleum products, synthetic methyl salicylate, oil of sweet birch and oil of sassafras.

**Methyl Salicylate (Methylis Salicylas)** U.S.P. (*Gaultheria Oil*, *Wintergreen Oil*, *Sweet Birch Oil*, *Betula Oil*) is a colorless, yellowish or reddish liquid with an odor and taste of wintergreen which is produced synthetically or obtained by maceration and subsequent distillation with steam from the leaves of *Gaultheria procumbens* (Fam. *Ericaceæ*) or from the bark of *Betula lenta* (Fam. *Betulaceæ*). It contains not less than 98 per cent of  $C_6H_4(OH)-CO_2CH_3$ . It must be labeled

to indicate whether it was made synthetically or distilled from either of the plants mentioned in its definition.

### SAPOTACEÆ (STAR APPLE FAMILY)

Tropical shrubs or trees (*Palaquium*) characterized by the presence of rows of laticiferous sacs in the pith and cortex of the stems and adjoining the veins of the leaves. Leaves alternate, exstipulate, evergreen and coriaceous. Flowers perfect, large and axillary. Fruit a berry (*Palaquium*) rarely a capsule (*Ponteria*).

### GUTTA PERCHA (GUTTA PERCHA)

**Synonyms.**—Gummi Plasticum, Gutta Pertscha, Gutta Taban.

**Botanical Origin.**—Trees of the genera *Palaquium* and *Payena*.

**Part Used.**—The purified, coagulated, milky exudate.

**Habitat.**—Malay Archipelago.

**Plants.**—Stately trees with reddish-gray bark, alternate, exstipulate, evergreen, coriaceous, obovate-lanceolate leaves, yellow or white flowers and ovoid berries. The leaves are smooth and bright green on the upper surface, yellowish-brown and silky on the lower surface.

**Production and Commerce.**—A number of species of *Palaquium* yield this drug, but the best article is obtained from *Palaquium gutta*, *Palaquium oblongifolia* and *Payena Leerii* growing on the islands of the Malay Archipelago, the Philippine Islands, and Sumatra. The grayish-white latex is formed in laticiferous sacs arranged in rows in the cortex, phloem and pith as well as in the leaves. It is usually obtained, during the wet season, by felling the trees, chopping off the branches and removing the bark in circular strips, forming channels about an inch wide and about a foot apart along the trunk. The latex exudes and fills these channels from which it is removed and boiled in open vessels over wood fires. It is then kneaded, some impurities such as wood removed, and made into blocks or cakes. Some gutta percha is also obtained by making V-shaped incisions in the living tree and the latex collected in cups. Most of it is sent from British, Philippine and Dutch possessions to Singapore thence to Europe and America. Gutta percha tissue has been imported from Germany. Most of the commercial article is at present produced in Sumatra and Malaya. The crude article is purified by washing chopped or sliced pieces in hot water, passing through a wire strainer to remove dirt and kneading by machinery to remove water. (Alkaline solutions or light petroleum are occasionally used to remove resin from the crude article.) It is then passed, while still hot and plastic, through rolling machines and comes out as sheets of varying degrees of thickness. The value of the drug is directly proportionate to the amount of the hydrocarbon, gutta, it contains.

**Description.**—Gutta Percha occurs in pliable and elastic masses, sticks or sheets of variable size and shape. It is tough, yellowish-white, usually with reddish streaks. It is insoluble in water and partly soluble in carbon disulfide, chloroform, petroleum benzin, or oil of turpentine, there being left not more



than 10 per cent. of undissolved residue. It is slowly dissolved by sulfuric and nitric acids. It should be preserved under water, for when exposed to air and sunlight it absorbs oxygen and becomes hard and brittle.

**Constituents.**—Up to 85 per cent. of the white hydrocarbon, *gutta* ( $C_{10}H_{16}$ ), which is soluble in ether, chloroform, petroleum ether and in volatile and fixed oils and which reddens on exposure to air; from 13 to 20 per cent. of two oxygenated resins, viz., *alban* ( $C_{10}H_{16}O$ ) (soluble in hot alcohol) and *fluavil* ( $C_{20}H_{32}O$ ) (soluble in cold alcohol); guttan, etc.

**Uses.**—Gutta percha is used in the manufacture of insulating material, surgical instruments, splints, supports, and gutta percha tissue, the latter being employed as a covering for moist dressings. It is sometimes dissolved in chloroform and applied as a protective covering to a wounded surface. It is also used in making dental cement for filling tooth cavities.

### CHICLE

**Synonyms.**—Gum Chicle, Mexican Chicle, Sapodilla Gum, Gum Zapotl.

**Botanical Origin.**—*Achras Zapota* Linné.

**Part Used.**—The dried latex.

**Habitat.**—Mexico and Central America.

**Plant.**—A tall evergreen tree which is cultivated in Tropical America and on the Florida Keys for its edible fruit known as the "Sapodilla."

**Production and Commerce.**—The bark of *Achras Zapota* contains a milky latex known as chicle, which is obtained by tapping the trunk of the tree and scraping the thickened exudate from the bark. This product is known as "crude chicle" or "loaf chicle," and is exported from Mexico, Honduras, Guatemala, Colombia, Venezuela, Brazil and Peru. During 1947, 13,761,396 pounds were imported into the United States.

**Description.**—*Crude chicle* occurs in irregular, pinkish to cherry-red or reddish-brown pieces with a considerable amount of adherent bark and usually with admixtures of stones, twigs and numerous insect remains. The extraneous matter is from 25 to 40 per cent. with different varieties of Mexican Chicle which are designated as "dark," "medium" and "light" chicle. Dark chicle is cherry-red in color, medium chicle, reddish-brown and light chicle, flesh colored.

*Purified chicle* occurs as an amorphous, pale pink colored powder, insoluble in water and ordinary solvents and, when heated, forming a tenacious sticky mass which, upon cooling, possesses a pink color. Upon ageing, it undergoes partial oxidation, becomes yellowish-brown to brown and very brittle. The purified article is prepared by first breaking the crude chicle into small pieces, placing them in a revolving screen drum and washing in a bath of strong alkali solution to remove extraneous matters. The drum and contents are then lifted out and placed in a bath of sodium acid phosphate to neutralize the alkalinity. The material is next washed with water until free from soluble salts and subsequently dried and powdered.

**Constituents.**—Similar to Gutta Percha but with less gutta and more resin.

**Use.**—Chicle is employed in the manufacture of medicated chewing gums.

**Allied Product.**—**Balata** is a dried latex obtained from *Manilkara bidentata* (A.DC.) Chevalier (*Mimusops Balata* Miq.) a tree indigenous to the West Indies and South America. It possesses the general properties of gutta percha and chicle and is employed in the manufacture of the bubble-balloon chewing gums. The crude article which is solid and somewhat crumbly is frequently adulterated with sticks, stones and other foreign matter. It is imported into this country from Brazil, Peru, Venezuela, Surinam, Colombia, British Guiana, the United Kingdom and Panama.

### STYRACEÆ (BENZOIN FAMILY)

Shrubs or low trees mostly indigenous to tropical America, many of which yield balsamic resins. Leaves alternate to opposite, entire, often acuminate. Flowers hermaphrodite, regular, rarely sub-irregular, either in condensed fascicles or solitary in the axils of the leaves; sepals and petals typically five each; corolla often white, rarely pinkish or yellowish; stamens many to 4 to 2, perigynous or sub-hypogynous; pistil bicarpellary or 4- to 5-carpellate. Fruit either fleshy or dry, often winged and rarely as many-celled as there are carpels.

### BENZOIN U.S.P. (BENZOINUM)

**Synonyms.**—Gum Benjamin, Benzoin Laurel, Benjamin Tree; *Ger.* Benzoe; *Fr.* Benzoin.

**Botanical Origin.**—*Styrax Benzoin* Dryander (Sumatra Benzoin) or *Styrax tonkinensis* (Pierre) Craib ex Hartwich or other species of the Section *Anthoxystrax* of the genus *Styrax* (Siam Benzoin).

**Part Used.**—A balsamic resin.

**Standard of Assay.**—Sumatra Benzoin yields not less than 75 per cent. of alcohol-soluble extractive. Siam Benzoin yields not less than 90 per cent. of alcohol-soluble extractive.

**Limit of Impurities.**—Sumatra Benzoin yields not more than 1 per cent of acid-insoluble ash. Siam Benzoin contains not more than 1 per cent. of foreign organic matter, and yields not more than 0.5 per cent. of acid-insoluble ash.

**Habitat.**—East Indies.

**Plants.**—Trees of medium height, having gray bark, oblong-ovate, acuminate, hairy leaves and axillary pink or white flowers which are borne on branched peduncles.

**Production and Commerce.**—The species of *Styrax* yielding Benzoin grow on hills and in plantations of Borneo, Java, Sumatra, Siam, North Annam and Tonkin. The uninjured bark of these plants has been found by Lüdy to contain tannin, traces of wax, phloroglucin and sugar but no balsamic resin. The same investigator has shown that neither a secretion nor secretion cells occur in the uninjured bark but instead large quantities of tannin and further, that the formation of balsam first takes place in those parts of the injured bark containing the tannin. Since the balsam contains a large amount of alcohol reacting like

tannin, viz., resino-tannol, it seems probable that the drug is at least in part produced from the tannin in the bark under morbid influence, possibly by fungi. The balsamic resin is collected during the summer and autumn from both wild and cultivated trees of 5 to 6 years or more growth by making incisions through the bark of the trunk with an axe. After injuring the tissues, the cambium rapidly produces new wood and bark in which one or more rings of resin reservoirs are formed. The tissue then breaks down between these reservoirs and large schizolysigenous reservoirs are formed, from which the balsamic resin flows out over the wound. The balsamic resin slowly exudes as a white liquid. When dry and hard it is scraped and picked off, placed in appropriate receptacles and assorted according to sizes, cleanness, etc. The trees yield the resin for about 12 years. The first three years' product is more fragrant and contains more white tears. This is known to the natives as "*head benzoin*." The next 7 to 9 years' yield is somewhat brown and termed "*belly benzoin*." The trees are subsequently felled and the trunk split. The product that is scraped off is of poor quality, of a dark-brown color, admixed with wood, bark, dirt and known as "*foot benzoin*." There are two officially recognized commercial varieties, namely, Siam and Sumatra Benzoin. Siam Benzoin, yielded by *Styrax tonkinensis* and possibly other species of the Sect. *Anihostyrax* of the genus *Styrax*, occurs in pebble-like tears of variable size, or as small tears agglutinated with a reddish-brown, glassy resin (Block Siam Benzoin). It is produced in the province of Luang Prabang of Siam where it is packed in cases for shipment. The largest amounts are imported into the U.S.A. from Bangkok and French Indo-China. Smaller lots have been received from Paris, Geneva and London.

Sumatra Benzoin yielded by *Styrax Benzoin* Dryander and probably also *S. sumatranus* J. J. Smith, occurs as irregular, reddish-brown, reddish-gray or grayish-brown masses. It is produced in Sumatra and Java mainly, wrapped in matting and conveyed to Padang, Penang and Singapore, where it is packed in chests weighing about 100 lbs. and sent into commerce. Most of it is imported from Palembang, Sumatra, Padang and Penang, although occasional lots come to us from France and the United Kingdom.

**Description.** *Siam Benzoin*.—It occurs as compressed, yellowish to rusty-brown, pebble-like tears of variable size, separate or slightly agglutinated with a reddish-brown resin; fracture milky-white; hard and brittle at ordinary temperatures but softened by heat and becoming plastic on chewing; odor balsamic, vanilla-like; taste aromatic and slightly acid.

**Identity Tests.** 1) The alcoholic solution becomes milky upon the addition of water, and the mixture is acid to litmus paper. 2) Upon boiling an acidulated solution of Siam benzoin with potassium permanganate, no odor of benzaldehyde should be evident (absence of appreciable amount of cinnamic acid). 3) Upon the addition of an ethereal solution of Siam benzoin to a small-quantity of sulfuric acid in a white porcelain dish, the solution should be colored purplish-red.

**Sumatra Benzoin.**—It occurs in the form of irregular, marbled masses of variable size, made up of tears imbedded in a reddish-brown, reddish-gray or

grayish-brown resinous substance; tears externally yellowish or rusty-brown, milky-white on fresh fracture; hard and brittle at ordinary temperatures, but softened upon heating and becoming gritty on chewing; odor aromatic and, upon digesting with boiling water, exhibiting an odor of storax or cinnamic acid; taste aromatic and slightly acid.

**Identity Tests.** ① The alcoholic solution becomes milky upon the addition of water, the mixture being acid to litmus paper. ② Upon boiling an acidulated solution with potassium permanganate, benzaldehyde is produced (presence of appreciable amount of cinnamic acid). If about 0.5 Gm. of Sumatra benzoin is heated in a test tube with 10 cc. of potassium permanganate T.S., it develops a strong odor of benzaldehyde.

③ Upon the addition of an ethereal solution of Sumatra benzoin to a small quantity of sulfuric acid in a porcelain dish, the solution should be colored brownish-red.

**Benzoin Microsublimation Test.**—Upon microsublimation, *Sumatra Benzoin* yields a sublimate of plates and small, rod-like crystals of cinnamic acid and its esters which strongly polarize light with a brilliant display of colors. *Siam Benzoin* yields a microsublimate of long, rod-like crystals of benzoic acid which do not strongly polarize light.

**Constituents.**—*Siam Benzoin* contains 77.8 per cent. of a benzoate of a resin alcohol called *coniferyl benzoate* ( $C_{17}H_{16}O_4$ ); 11.7 per cent. of free *benzoic acid*, 6 per cent. of *siarésinolic acid*, *cinnamyl benzoate*, *vanillin*, etc.\* *Sumatra Benzoin* consists chiefly of esters of cinnamic and benzoic acids associated with free acids. Two alcohols are present one known as *benzorésinol*, the second probably *coniferyl alcohol*, both combined with *cinnamic* and *benzoic acids*, about 10.3 per cent. of free *cinnamic acid*, about 6.5 per cent. of free *benzoic acid*, *phenylpropyl ester of cinnamic acid*, *benzaldehyde*, *cinnamic cinnamate*, *styrol*, *styracin*, etc.

**Uses.**—*Siam Benzoin* is used chiefly in the manufacture of toilet preparations and as a fixative in the manufacture of perfumes. *Sumatra Benzoin* is employed internally as a stimulating expectorant and externally as a stimulant and antiseptic. Benzoin is also employed by the confectionery trade in the preparation of vanilla creams, etc. and by the leather trade as an ingredient of leather dressings.

**Average Dose.**—1 Gm. (15 grains).

**Preparations.**—Benzoinated Lard U.S.P. (made with *Siam Benzoin*); Benzoin Tincture, U.S.P., 1 cc.; Compound Benzoin Tincture, U.S.P., 2 cc.; Compound Tar Ointment (from Benzoin Tr.), N.F.

#### OLEACEÆ (OLIVE FAMILY)

*Oleaceæ* or *Olive Family*.—Shrubs (*Forsythia* or Golden Bell, *Syringa* or Lilac, etc.) or trees (Ash, Olive, Fringe Tree, etc.) with stems possessing close white wood, and slightly swollen or enlarged nodes. Leaves opposite, decussate,

\* Cocking and Kettle (*Trans. Br. Ph. Conf.* 1914) claim that *Siam benzoin* contains 3 per cent of cinnamic acid. In that proportion, it will not respond to the permanganate test.

simple, rarely pinnately compound (Ash). Stems and leaves with bicollateral bundles. Inflorescence dichesial or scorpioid cymes but tending constantly toward condensation and so, in the Lilac, the inflorescence becomes a clustered raceme of cymes (thyrsus). Flowers regular, pentamerous or tetramerous; sepals small, green, rarely petaloid, synsepalous; petals synpetalous, elongated into a narrow tube, expanding above into a stellate limb; stamens very rarely five, rarely four to three, nearly always two, epipetalous and high set on corolla tube; pistil bicarpellate, rarely of three to four carpels; ovary two-celled with two to one pendulous ovules in each cavity. Fruit either a capsule (Lilac), drupe (Olive), berry (Privet) or a winged indehiscent akene (Ash). Seeds with moderate to scanty albumen becoming occasionally albuminous.

OLIVE OIL U.S.P. (OLEUM OLIVÆ)

**Synonyms.**—*Sweet Oil*; *Ger.* Olivenöl; *Fr.* Huile d'Olive.

**Botanical Origin.**—*Olea europæa* Linné.

**Part Used.**—The fixed oil obtained from the ripe fruit.

**Habitat.**—Probably the Levant.

**Plant.**—A small tree rarely over 25 ft. in height, with grayish bark, opposite, evergreen, entire, lanceolate leaves, smooth and dark green on their upper surfaces and whitish beneath. The yellowish-white flowers are borne in axillary racemes. The fruit is a smooth, oblong to oval drupe with a fleshy mesocarp, green at first but becoming deep violet when ripe.

**Production and Commerce.**—The olive has been cultivated in Mediterranean countries from a remote period of history, the olive industry still being an important one in Spain, southern France and Italy. The tree has been introduced into California and Australia, the former state now yielding an annually increasing crop of olives which are claimed to yield up to 50 per cent. of oil when ripe. The fixed oil is formed during the ripening of the fruit and stored in the sarcocarp. The fruits are collected from November to April, the unripe fruits being usually separated from the ripe and the former used for "pickled olives." The ripe fruits are crushed and the oil pressed out. This is called "*crude olive oil*." The crude oil is then run into containers and mixed with water in order to remove impurities. The oil rising to the surface is skimmed off and filtered. This first cold pressed oil which possesses a greenish hue is called "*virgin olive oil*" and is the kind intended for internal administration. The pulp remaining is ground, mixed with hot water and subjected to considerable pressure, the product yielding a second grade oil which is used for culinary purposes and manufacture of fine soaps. The residue is either subjected to a third pressing or extracted with solvents and used in the soap industry. An oil used entirely for technical purposes is obtained by allowing the olive oil fruits, placed on heaps, to ferment and then pressing out the oil. Most of the olive oil used in the United States is imported from Spain, Italy, Portugal, Syria, Palestine, Iran, Greece, French Morocco and Turkey. A considerable amount comes from California. During 1946, 12,659,912 pounds of olive oil were imported into this country.



FIG. 324.—The Manna Ash (*Fraxinus ornus*). 1. Flowering branch. 2. Expanded flower. 3. Unopened anthers. 4, 5. The calyx and pistil. 6. Vertical- and 7. Transverse section of same. 8. Fruit (a single samara). 9. Vertical section of same and seed. 10. Fruit with a part of the pericarp removed, showing the ripe seed. 11. Transverse section of seed. (After *Beniley and Trimen*.)

**Description.**—A light greenish-yellow or pale yellow oily liquid, possessing a slight peculiar odor and taste with a faintly acrid after-taste; slightly soluble in alcohol but miscible with ether, chloroform and carbon disulphide; sp. gr. 0.910 to 0.915 at 25°C. At 10° to 8°C. it becomes cloudy from the separation of crystalline particles of fat and at 0°C. it forms a whitish, granular mass.

**Constituents.**—Chiefly *olein* but also some palmitin, linolein and traces of arachnin.

**Uses.**—Nutrient, laxative, emollient; in enemas for fecal impaction, etc.

**Average Dose.**—30 cc. (1 fl. oz.).

**Adulterants.**—Cottonseed oil, sesame oil, peanut oil, and teaseed oil. For detection see U.S.P. XIII.

#### MANNA (MANNA)

**Synonyms.**—Manna Ash; *Fr.* Manne; *Ger.* Manna.

**Botanical Origin.**—*Fraxinus Ornus* Linné.

**Part Used.**—The dried saccharine exudation.

**Purity Rubric.**—Not less than 75 per cent. of anhydrous extractive, soluble in boiling alcohol, and not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—Southern Europe.

**Plant.**—A small tree bearing imparipinnate leaves, each with 7 ovate, acuminate, serrate leaflets, and panicles of small white flowers. The fruit is a winged akene (samara).

**Production and Commerce.**—The manna ash is cultivated for the drug chiefly in Italy and Sicily. When the trees are about 8 years of age transverse incisions are made with a knife in the bark of one side of the stem, daily, beginning from the ground upward at succeeding higher levels and 4 to 5 cm. apart. The manna exudes as a clear liquid which, after hardening, is collected by hand from the side of the trunk (*flake manna*) or in special receptacles.

Five Italian provinces (in Sicily) supply most of the world's consumption of manna which occurs in 6 commercial varieties, as follows:

Manna, flake, Capaci, 62.15 per cent. mannite
Manna, flake, Geraci, 62 per cent. mannite
Manna, flake, Frassino, 47 per cent. mannite
Manna, sorts, Capaci, 37–55 per cent. mannite
Manna, sorts, Geraci 37 per cent. mannite
Manna, sorts, Castelbuono, 28–30 per cent. mannite

Manna has been imported into the United States from Palermo, Italy, and from the United Kingdom, packed in cases. During 1946, 37,224 pounds were imported into this country.

**Description.**—In irregular, more or less elongated, flattened, 3-sided pieces, externally yellowish-white or cream colored; friable, somewhat waxy; internally nearly white, porous and crystalline, from 10 to 25 cm. in length (*large flake manna*) or in shorter, yellowish-white to yellowish-gray pieces (*small flake manna*), or in irregular yellowish-brown masses consisting of agglutinated tears

and vegetable fragments (*manna in sorts*); odor slight; taste sweet, slightly bitter and faintly acrid.

**Constituents.**—From 60 to 90 per cent. of *mannitol* (mannite); a bitter fluorescent glucoside called *fraxin*; 2 sugars, *manninotriose* and *manneotetrose*, mucilage, resin, etc. Mannitol, the chief constituent, crystallizes in aggregates of needles and in orthorhombic prisms from aqueous solutions.



FIG. 325.—The Fringe Tree, *Chionanthus virginicus*.

**Uses.**—Manna is used as a laxative for children and occasionally as a pill excipient for calomel, etc.

**Average Dose.**—15 Gm. (4 drachms).

**Adulterants.**—1. Glucose. 2. Bread crumbs. 3. Sucrose.

#### CHIONANTHUS (CHIONANTHUS) H.P.

**Synonyms.**—*Fringe Tree Bark*, Flowering Ash, Old Man's Beard.

**Botanical Origin.**—*Chionanthus virginicus* Linné.

**Part Used.**—The dried bark of the root. The fresh bark is recognized by the Homeopathic Pharmacopœia.

**Purity Rubric.**—Not more than 5 per cent. of adhering wood or other foreign organic matter. It yields not more than 2 per cent. of acid-insoluble ash, and not less than 35 per cent. of anhydrous extractive soluble in 73 per cent., by volume, of alcohol. N.F. VII.



**Habitat.**—Southern United States as far north as Pennsylvania and New Jersey.

**Plant.**—A low deciduous, dioecious tree with opposite, petiolate, ovate to obovate-lanceolate leaves and drooping panicles of white flowers, each with 5 or 6 white linear petals. The fruit is an ovoid, purple drupe.

**Production and Commerce.**—The bark is collected in autumn from roots of trees growing in Virginia and North Carolina and carefully dried.

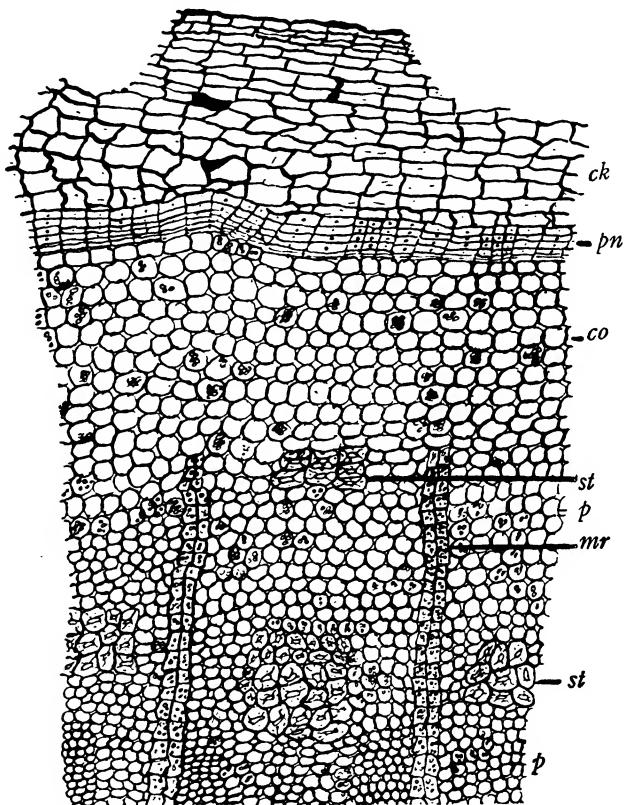


FIG. 326.—*Chionanthus* Root Bark. Transverse section,  $\times 25$ . *ck*, cork; *pn*, phellogen; *co*, cortex; *p*, phloem; *st*, group of stone cells; *mr*, medullary ray. [After Youngken and Feldman, *Jour. A.Ph.A., Sci. Ed.* 31 (1942) 130.]

**Description.**—It occurs as irregularly broken, transversely curved or flat pieces, occasionally in single quills up to 10 cm. long, bark from 2 to 10 mm. in thickness; heavy, some pieces of the whole drug sinking when thrown into water; outer surface rough, usually dusky brown to light yellowish-brown, with few transverse wrinkles, scaly, roughened by shallow pits, lighter colored cork patches, and root scars; some pieces with circular, raised lenticels; inner surface moderate brown to weak yellowish-orange, longitudinally striate and undulate; fracture short, hard and coarsely granular, due to projecting groups of stone cells; fractured surface yellowish-white to light brown; odor aromatic; taste bitter.

**Histology.**—Transverse sections mounted in chloral show the following characteristics:

1. *Cork* of several layers of tangentially-elongated cells with suberized and lignified walls, a number of which contain a yellowish-brown oily substance. No stone cells occur in this region (*distinction from stem bark*).

2. *Cork cambium* of meristematic cells.

3. *Secondary Cortex*, of many layers of thin-walled cortical parenchyma. the cells of which contain prismatic crystals or simple and compound starch grains. Imbedded in this region are scattered groups of stone cells.

4. *Phloem*, a broad zone of small celled phloem parenchyma, scattered groups of sieve tubes and companion cells and nearly straight medullary-rays. Imbedded in this region are scattered groups of stone cells. The medullary-rays are 1 to 3 cells wide.

**Powdered Drug.**—Weak yellowish-orange; numerous porous stone cells in groups and isolated with thick, lignified walls, up to about  $295\mu$  in length and  $125\mu$  in diameter; numerous brownish, resin masses; fragments of light brown cork tissue with polygonal shaped cells; fragments of parenchyma, many of the cells filled with small prismatic crystals, some with starch; starch grains spheroidal, simple or 2- to 4-compound, the individual grains mostly to  $20\mu$  in diameter, occasionally up to  $27\mu$  in diameter; a few short fibers up to about  $200\mu$  in length and  $45\mu$  in diameter with lignified, lamellated, walls with simple pores and blunt or truncated ends and representing elements of bark at base of stem covered with soil; few fragments of cork cells.

**Constituents.**—A bitter glycoside, *chionanthin*, a hemolytic saponin, etc.

**Uses.**—Bitter tonic, diuretic and aperient. Formerly used in the treatment of jaundice and portal congestion.

**Average Dose.**—2 Gm. (30 grains).

**Preparation.**—Fluidextractum Chionanthi, 2 cc. (30 minims).

**Adulterant.**—Stem bark of *Chionanthus virginicus*.

#### LOGANIACEÆ (NUX VOMICA FAMILY)

Herbs (*Spigelia*, etc.), woody vines (*Gelsemium*, etc.) or trees (*Strychnos Nux-vomica*, etc.) with a bitter juice usually containing alkaloids. Stem, rarely herbaceous, usually woody, often long-climbing and rope-like (*Gelsemium*), usually with a bicollateral bundle system. Leaves opposite, stipulate or exstipulate. Inflorescence racemose or cymose (*Spigelia*), a scorpioid cyme (*Strychnos*), sometimes condensed into solitary, axillary flowers. Flowers perfect, usually regular; calyx gamosepalous; corolla gamopetalous, hypogynous, rotate, campanulate or infundibuliform; stamens inserted on the corolla tube or throat and with thread-like filaments; ovary superior, two-celled; style elongate with bifid stigma; ovules numerous. Fruit usually a capsule, septicidally dehiscent (*Gelsemium sempervirens*), or loculicidally dehiscent (*Spigelia marilandica*), sometimes a berry (*Strychnos Nux-vomica*) or drupe. Seeds numerous or solitary, sometimes winged.

## GELSEMIUM N.F. (GELSEMIUM)

**Synonyms.**—*Yellow Jasmine Root*, Yellow Jessamine, Trumpet Flower; *Ger.* Giftjasmin; *Fr.* Jasmine sauvage.

**Botanical Origin.**—*Gelsemium sempervirens* (Linné) Persoon.

**Part Used.**—The dried rhizome and roots.



FIG. 327.—Gelsemium. Note the slender wiry roots emanating from the rhizomes. Characteristic fissures appear in the lower portion of the rhizome to the right.  $\times \frac{1}{2}$ .

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—Eastern United States from Virginia to Florida and Texas.

**Plant.**—A perennial woody twiner with purplish stem and opposite, short petioled, ovate-lanceolate to lanceolate entire leaves, axillary clusters of yellow funnel-form or trumpet-shaped flowers and 2-celled, flat, capsular fruits containing several winged seeds in each cell.

**Production and Commerce.**—The rhizomes and roots are dug up in autumn, washed and dried. The commercial supplies of Gelsemium are collected in Virginia, North and South Carolina, Tennessee and Georgia.

**Description.**—The drug occurs as segments of the cylindrical rhizome with attached wiry roots. Rhizome horizontal, the segments from 3 to 20 cm. in length and from 3 to 30 mm. in diameter; externally moderate brown to dark yellowish-orange, frequently spirally twisted, longitudinally wrinkled, with purplish-brown longitudinal lines and transverse fissures; upper surface with few stem scars, the under and lateral portions with several roots and root scars; fracture of rhizome tough, splintery; internally exhibiting a narrow purplish-

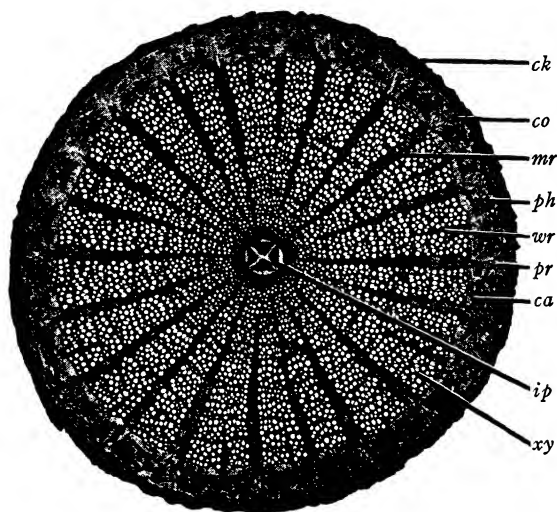


FIG. 328.—Gelsemium. Transverse section of rhizome. Photomicrograph.  $\times 10$ . *ck*, cork; *co*, cortex; *mr*, medullary ray; *ph*, phloem; *wr*, wood ray; *pr*, phloem ray containing calcium oxalate crystals; *ca*, cambium; *ip*, internal phloem; *xy*, secondary xylem.

brown bark, a broad, pale yellowish orange to weak yellow, finely radiate and eccentric wood and a minute disintegrated pith; odor indistinct; taste strongly bitter.

Roots up to 20 cm. in length and from 2 to 8 mm. thick; light brown, nearly smooth and wiry; fracture one-half transverse, the other oblique and splintery; fractured surface showing a broad, radiate, yellow wood and a thin bark.

**Histology.**—Transverse sections of the *rhizome* show the following microscopical peculiarities.

1. *Cork*, of several layers of yellowish-brown more or less lignified cells.
2. *Cork cambium* of meristematic cells.
3. *Cortex* of numerous layers of parenchyma cells containing spherical starch grains. In the outer part of this region occur scattered groups of *sclerenchyma elements* (stone cells or fibers).
4. *Outer Phloem*, a narrow zone of phloem patches, containing sieve tubes and phloem cells, separated from each other by phloem portions of medullary-

rays which show a marked contrast to the xylem portions of medullary-rays in being non-lignified. In various cells of the medullary rays of the phloem occur *long monoclinic prisms of calcium oxalate*.

5. *Cambium*, of small meristematic cells.

6. *Xylem*, a broad radiate zone composed of wedge-shaped xylem patches consisting of large, broad, porous tracheæ and small, narrow, thick-walled, porous tracheids. Each xylem patch is separated from its neighbor by a multicelleate xylem medullary ray, the cells of which contain starch and have lignified walls.

7. *Cambium*, of meristematic cells.

8. *Internal Phloem*, consisting usually of 4 masses of sieve tubes and phloem parenchyma.

9. *Pith*, a very small central zone of more or less disintegrated nonindurated cells; in very old rhizomes completely absent.

Transverse sections of the *root* show a similar structure to that of the rhizome except that the pith, internal phloem, and the stone cells are absent.

**Powdered Drug.**—Light yellowish-brown to weak yellow; numerous tracheæ with bordered pores and tracheids with lignified walls; a few spiral tracheæ; numerous spheroidal starch grains from 4 to 12 $\mu$  in diameter; occasional groups of stone cells and narrow sclerenchyma fibers with lignified walls; monoclinic prisms of calcium oxalate from 15 to 32 $\mu$  in length; fragments of more or less lignified cork; fragments of lignified xylem medullary-rays the cells of which contain starch.

**Constituents.**—The crystalline alkaloids *gelsemine* and sempervirine, the motor neuron depressant alkaloid *gelsemicine*, the amorphous alkaloids *gelseminine* and *gelsemoidine*; scopoletin, emodin monomethyl ether, gelseminic acid, fixed oil, resins, gallic acid, etc. Gelseminine is a depressant to the motor areas of the cord, acting like coniine. Gelsemicine is highly toxic.

**Uses.**—Motor depressant. Employed in the treatment of refractory trifacial neuralgia, migraine, asthma, spasmodic dysmenorrhœa, etc.

**Average Dose.**—30 mg. ( $\frac{1}{2}$  grain).

**Poisoning.**—The symptoms are dropping of the jaw, dilated pupils, double vision, general muscular weakness and prostration, lowered body temperature, slow pulse, labored respiration. Death is caused by failure of respiration. The treatment consists of emptying and washing out stomach, maintaining rest in a horizontal position, keeping body warm, and of the administration of circulatory stimulants, as digitalis and ammonia, and a spinal stimulant, strychnine, hypodermically. Artificial respiration may be necessary.

**N.F. Preparations.**—Gelsemium Fluidextract, 0.03 cc. ( $\frac{1}{2}$  minim); Gelsemium Tincture, 0.3 cc. (5 minims); Compound Sodium Salicylate and Gelsemium Elixir, 4 cc. (1 fl. dr.).

**Adulterants.**—(1) Aerial stems of *Gelsemium sempervirens*. These differ microscopically from the rhizome in showing collenchyma containing chloroplasts in the outer cortex and in having an interrupted circle of groups of sclerenchyma fibers in the pericycle. They are frequently reddish-brown to

dark brown externally and show greenish bark, upon scraping off the cork.  
 (2) The rhizome and roots of *Jasminum fruticans* L. which shows bast fibers outside of each sieve mass.

#### SPIGELIA H.P. (SPIGELIA)

**Synonyms.**—*Pink Root*, American Worm Root, Worm Grass, Indian-, Maryland-, Carolina-, or India Pink; *Ger.* Spigellie, *Fr.* Spigélie du Maryland.

**Botanical Origin.**—*Spigelia marilandica* L.

**Parts Used.**—The dried rhizome and roots.

**Habitat.**—In rich woods from New Jersey and Maryland to Kentucky, south to Florida and Texas.

**Plant.**—A perennial herb, the underground portion of which consists of a slender branched, knotty, horizontal, or slightly oblique rhizome from the sides and lower surface of which numerous long slender fibrous roots are given off. From the upper surface of the rhizome several aerial 4-angled stems arise that attain a height of .3 to .6 m. and bear opposite, sessile, ovate, acute, entire leaves. The elongated, tubular-funnel-shaped flowers appear from May to July along one side of the spike terminating the stem. The corolla of each flower is scarlet-red outside, yellow within and 5-lobed at the summit. The fruit is a 2 chambered, loculicidally dehiscent capsule containing yellowish seeds.

**Production and Commerce.**—Pink root was formerly collected in large amounts in North Carolina and Tennessee but is becoming very scarce in these states at present. Most of the commercial article is now gathered in Mississippi. It is packed in bales wrapped with gunny sack.

**Description.**—Rhizome more or less branched, entire or in pieces 1.5 to 7 cm. in length and from 2 to 5 mm. in diameter; externally dark brown, finely annulate, the upper surface knotty from stem bases, the latter attaining a length of 6 cm. and a diameter of 3 mm. and possessing nodes with opposite leaf scars; the lower and lateral portions of the rhizome bearing many long, coarse, finely branched, brittle roots; fracture short, brittle and uneven, the inner surface showing nearly equal zones of white bark, yellow wood and dark



FIG. 329.—*Spigelia marilandica* L., the Pink Root. Leaf and flowering branch.  $\times \frac{1}{2}$ .

pith. Rootlets up to 10 cm. long, few if any of which show terminal portions with bark removed from the wood.

**Histology of Rhizome.**—1. *Epidermis* of dark brown epidermal cells with thickened outer walls. 2. *Cortex* of from 10 to 15 layers of isodiametric cells containing spheroidal to somewhat polygonal starch-grains up to  $6\mu$  in diameter. 3. *Endodermis* of tangentially-elongated clear cells with Casparyan spots on their radial walls. 4. *Phloem*, of sieve tubes and phloem parenchyma, this zone

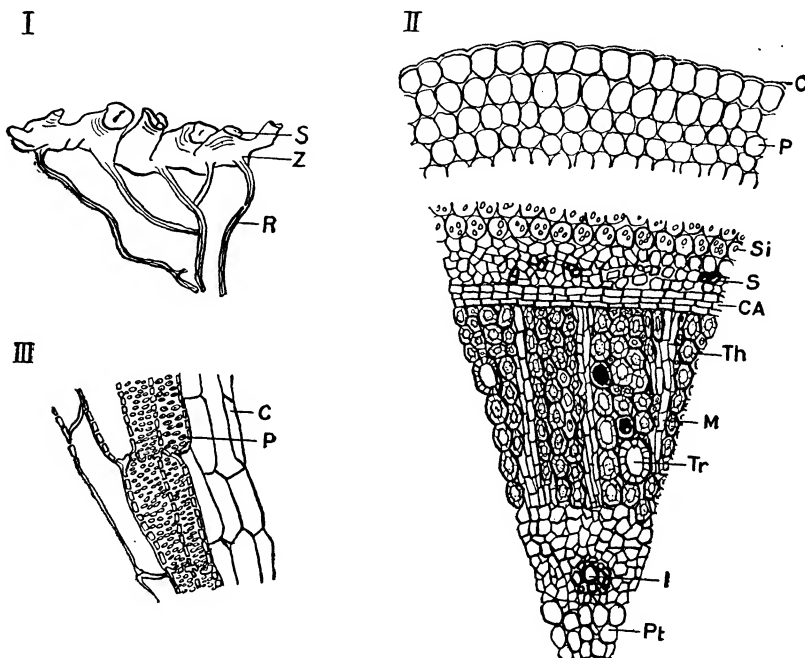


FIG. 330.—I, Habit sketch of *Spigelia*. Stem scar (S); rhizome (Z); root (R). II, Transverse section of a rhizome of *Spigelia*. Cuticle of yellowish-brown color, covering epidermis (C); cortical parenchyma (P); starch parenchyma (Si); sieve tissue (S); cambium (CA); trachea (Tr); tracheids (Th); internal phloem (I); medullary-ray (M); pith (Pt). III, Longitudinal view of porous tracheae (P) and parenchyma (C).

up to  $150\mu$  broad. 5. *Cambium*. 6. *Xylem*, a compact zone of radially arranged, lignified tracheids and tracheae with bordered pores, a few with spiral thickenings. 7. *Intraxylary phloem*, a narrow zone containing groups of sieve tubes surrounded by phloem parenchyma. 8. *Pith*, of thin-walled parenchyma, many of the cells containing small starch grains.

**Histology of Root.**—Transverse sections of the rootlets show a hairy epidermis, a broad cortex of somewhat rounded parenchyma cells containing numerous small starch grains, an endodermis and pericambium, 6 to 8 alternating xylem and phloem patches forming a radial fibro-vascular bundle, and a small central pith.

**Powdered Drug.**—Grayish-brown. Fragments of lignified tracheae and tracheids having bordered pores. Starch grains simple, spheroidal or more or

less polygonal, 2 to 6 $\mu$  in diameter. Fragments of reddish-brown epidermal cells and starch parenchyma.

**Constituents.**—A *bitter anthelmintic principle* occurring throughout plant, amines, resins, starch, fat, etc.

**Use.**—Pink root is used as an anthelmintic; often in combination with senna.

**Average Dose.**—2 Gm. (30 grains). **Preparations:** Fluidextract, 2 cc.; Fluidextract of Pink Root and Senna, 2 cc.

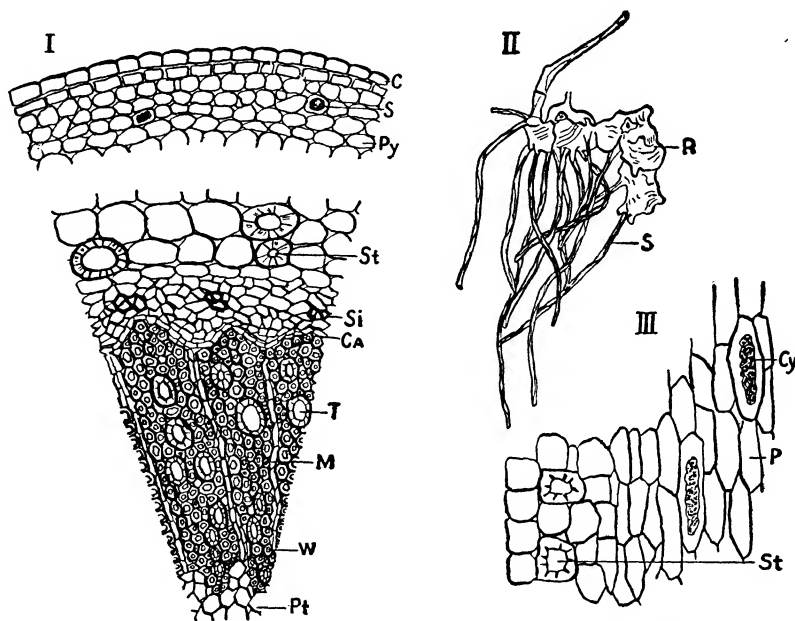


FIG. 331.—I, Transverse section of *Ruellia ciliosa* rhizome. Epidermis (C); cystolith (S); cortex (Py); stone cell (St); sieve tissue (Si); cambium (Ca); trachea (T); medullary-ray (M); wood fibers (W); pith (Pt). II, Habit sketch of *Ruellia*. Rhizome (R); root (S). III, Longitudinal section through cortex of *Ruellia*. Cystolith (Cy); parenchyma (P); stone cell St.

**Substitutes and Adulterants.**—The most common substitute and adulterant has been the rhizome and roots of *Ruellia ciliosa* Pursh. (Fam. *Acanthaceæ*), commonly known as East Tennessee Pink Root, a perennial herb, somewhat resembling *Spigelia* but with light bluish-purple axillary flowers, and often found growing in vicinities where the latter abounds. The rhizome and roots of *Phlox ovata* L. (*Phlox Carolina*) (Fam. *Polemoniaceæ*), the Carolina Pink of Southern United States, are stated to have been occasionally admixed with the drug. The important differences between *Spigelia*, *Ruellia* and *Phlox* underground portions may be tabulated as on page 662.

#### NUX VOMICA N.F. (NUX VOMICA)

**Synonyms.**—Dog Button, Quaker Button, Poison Nut, *Strychni semen* P.I.; Ger. Brechnuss; Fr. Noix-vomique.

**Botanical Origin.**—*Strychnos Nux-vomica* Linné.



**Part Used.**—The dried ripe seed.

**Standard of Assay.**—Not less than 1.15 per cent. of strychnine.

**Habitat.**—India.

**Plant.**—A tree with crooked trunk and irregular branches having yellowish-gray bark. Its leaves are opposite, ovate, exstipulate, glabrous, 3- to 5-nerved with acute apex. Its flowers are greenish-white, tubular, and appear during the winter in terminal scorpioid cymes. Its fruit is an orange-yellow spheroidal berry containing up to 5 orbicular seeds, imbedded in a starch-containing, glutinous pulp.

Spigelia	Ruellia	Phlox
<i>Rhizome:</i> Horizontal or slightly oblique.	<i>Rhizome:</i> Oblique.	<i>Rhizome:</i> Vertical.
Rootlets arising from sides and lower surface.	Rootlets arising from sides and lower surface.	Rootlets arising laterally from nodes (2 to 4 from each node).
Cystoliths absent in cortex and pith.	Cystoliths present in cortex and pith.	No cystoliths.
Intraxylary phloem present.	Intraxylary phloem present.	Intraxylary phloem absent.
Stone cells generally absent.	Stone cells in cortex much elongated and lignified.	Stone cells short or elongated, less thickened than those of Ruellia.
<i>Root:</i> Bark not readily detached from wood.	<i>Root:</i> Bark readily detached.	<i>Root:</i> Bark readily removable.
Rootlets numerous.	Rootlets numerous.	Rootlets few and thicker than those of Spigelia and Ruellia.
No stone cells.	Stone cells numerous.	No stone cells.
Cystoliths absent.	Cystoliths present.	No cystoliths.
<i>Petroleum benzin extract:</i> Yellow to brownish yellow.	Red, fluorescent.	Yellow to brownish yellow.

**Production and Commerce.**—*Strychnos Nux-vomica* grows wild in the forests of India, from the eastern seaboard far into the interior, and also in the forests of Ceylon, Burma, Siam, Cochin China and northern Australia. Two-thirds of the world's supply of *Nux vomica* is furnished by the Madras Presidency of India. The drug is gathered and prepared in the hills of Travancore and Cochin, along the Malabar coast and in the Ganjam, Godavery and Nellore districts on the Coromandel coast. The forest tribes gather the fruits when dead ripe and wash off the pulp or permit it to rot off and then spread the seeds on mats in the sun to dry. The seeds are then sold to small middlemen from whence they pass through the hands of larger middlemen to the large exporters at Madras, Cochin and Coconada. The exporters wash and sort the seeds, separating the broken ones and the "floaters" (underweight seeds). They are then packed in burlap bags, each containing 162 or 182 pounds of seed and exported chiefly to the United States and Great Britain. The cullings and broken seeds are imported for alkaloid manufacture. The commercial supplies are imported into the United States from India and French Indo-China. During 1946, 3,235,454 pounds of *nux vomica* were imported into the United

States. The important commercial varieties are the Madras, Cochin, Telli-cherry and Ceylon.

**Description.**—Orbicular, nearly flat, occasionally irregularly bent, from 10 to 30 mm. in diameter and from 3 to 5 mm. in thickness, very hard when dry; externally grayish or from pale brown to pale olive, covered with appressed hairs

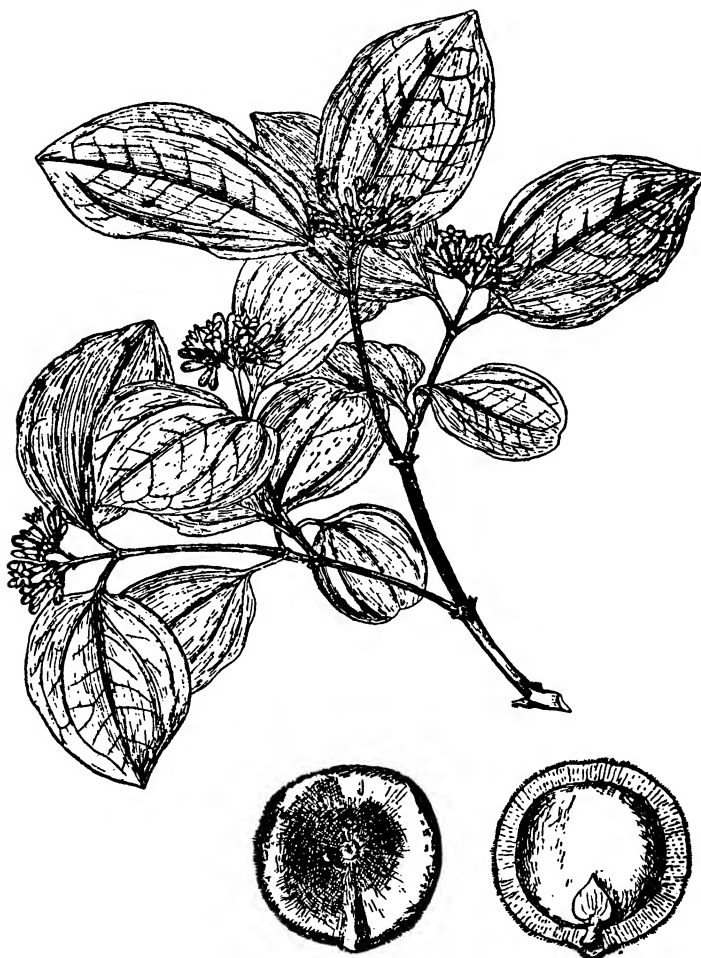


FIG. 332.—*Strychnos Nux-vomica*—Flowering branch and seeds. (Sayre.)

giving it a silky luster, hilum indicated by a circular scar at the center of one of the flattened sides and connected with the micropyle at the edge by a radial raphe; internally showing a thin, hairy seed-coat and a large yellow to weak yellowish-green endosperm at one end of which is embedded a small embryo with two cordate, 5- to 7-nerved cotyledons; inodorous; taste intensely and persistently bitter.

**Histology.**—Cross sections of the seed exhibit a thin spermoderm of collapsed cells from which project numerous appressed, twisted, thick-walled, lignified

hairs with enlarged bases possessing slit-like pits and branched lumina, their long bent bodies possessing walls with long, curved, narrow slits. Beneath the spermoderm occurs a broad endosperm of polygonal cells showing well marked plasmodesmata, very thick walls of reserve cellulose and lumina containing oily plasma and occasional aleurone grains.

**Powdered Drug.**—Pale brown to yellowish-gray; consisting chiefly of thick-walled endosperm cells containing globules of a fixed oil and a few small aleurone grains, and fragments of strongly lignified, non-glandular hairs, the walls of the



FIG. 333.—Original bags of Nux Vomica from India. (Courtesy of Parke, Davis and Company.)

latter possessing large, circular, or long, slit-like pores. In the tissues of the adhering pulp occur a few small, nearly spherical starch grains.

**Constituents.**—From 1.84 to 5.3 per cent. of the alkaloids *strychnine* ( $C_{21}H_{22}O_2N_2$ ) and *brucine* ( $C_{23}H_{26}O_4N_2 \cdot 4H_2O$ ); a glucoside termed *loganin*, igasuric acid, protein, fixed oil, etc. Strychnine crystallizes from alcoholic solutions in the form of orthorhombic prisms.

**Uses.**—Nux Vomica and strychnine are employed as a spinal stimulant (excito-motor) and bitter tonic in debility with loss of appetite, in convalescence from severe illness, in serious acute diseases; in poisoning from alcohol, chloral, ether or barbiturates, in diminished vision, sexual impotence, post operative

paralysis of intestines, in infantile paralysis, etc. Strychnine is also employed in poison baits for rats and other rodents.

**Average Dose.**—0.1 Gm. ( $1\frac{1}{2}$  grains); of Strychnine (N.F.), 1.5 mg. ( $\frac{1}{40}$  grain); of Strychnine nitrate (N.F.) and Strychnine sulfate (U.S.P.) and Strychnine phosphate (N.F.), 2 mg. ( $\frac{1}{30}$  grain); of Brucine sulfate (N.F.) 2 mg. ( $\frac{1}{30}$  grain).

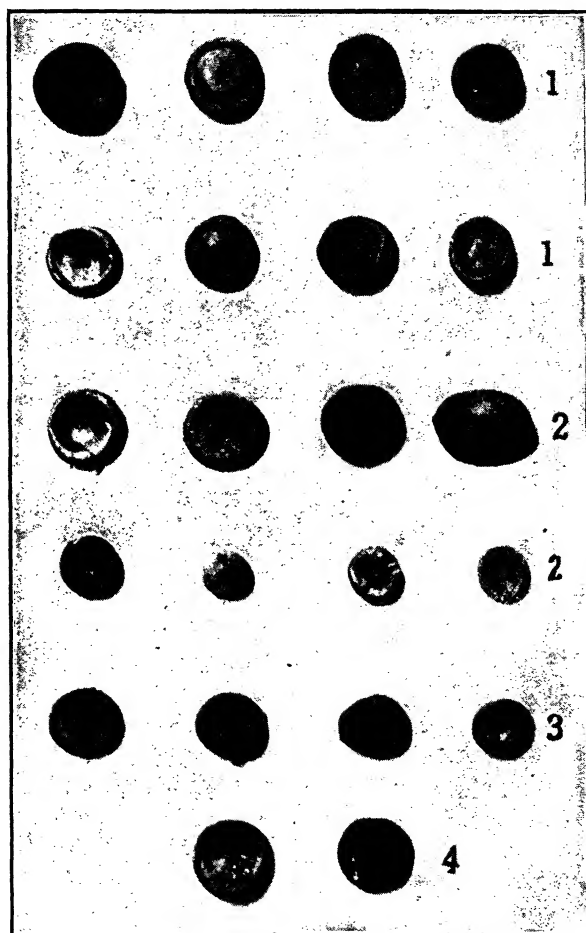


FIG. 334.—Commercial varieties of *Nux Vomica*. (1) Ceylon; (2) Cochin; (3) Madras; (4) Tellicherry.  $\times \frac{1}{2}$ .

**Preparations.**—*Nux Vomica* Extract (*Extractum Strychni P.I.*), N.F., 15 mg. ( $\frac{1}{4}$  gr.); *Nux Vomica* Tincture, N.F. (*Tinctura Strychni P.I.*), 1 cc. (15 minims); *Nux Vomica* Fluidextract, N.F., 0.1 cc. ( $1\frac{1}{2}$  minims).

#### IGNATIA (IGNATIA)

**Synonyms.**—Saint Ignatius Bean, *Ignatia Amara*; *Fr.* Fève de Saint-Ignace; *Ger.* Ignazbohne, Bittere Fiebernuss.

**Botanical Origin.**—*Strychnos Ignatii* Bergius.

**Part Used.**—The dried ripe seed.

**Purity Rubric.**—Nor less than 2 per cent. of Ignatia alkaloids and not more than 1 per cent. of foreign organic matter (N.F. V).

**Habitat.**—Philippine Islands.

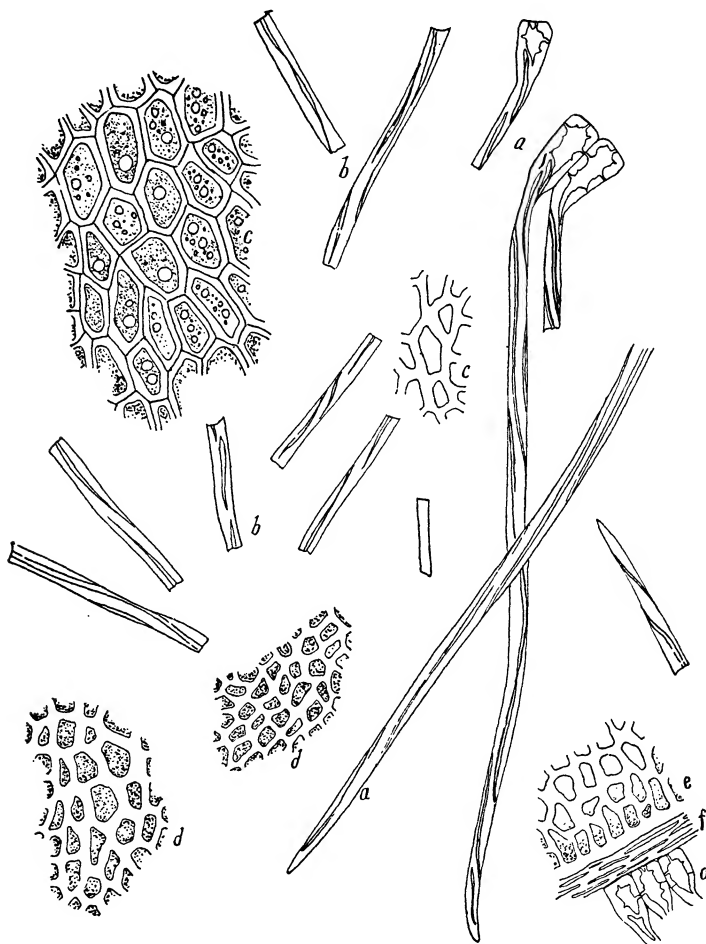


FIG. 335.—Powdered Nux Vomica. (a) Trichomes, lignified throughout; (b) trichomatic fragments; (c, d) endosperm tissue; (e) outer endosperm, lateral view; (f) hypodermal tissue. (Schneider.)

**Plant.**—A tall climbing shrub with opposite, exstipulate, ovate, glabrous leaves and white tubular flowers. The fruit is a large pyriform berry containing up to 24 pebble-like seeds imbedded in a bitter pulp.

**Commerce.**—The commercial supplies of this seed are obtained from the Philippine Islands.

**Description.**—Heavy, hard, angularly ovate with obtuse angles, from 20 to 30 mm. in length and about 15 mm. in breadth and thickness; externally grayish

or reddish-black, nearly smooth with few or no hairs; fracture granular and translucent in small fragments; a small irregular cavity in the center. Nearly inodorous and intensely bitter.

**Powdered Drug.**—Grayish-brown; exhibiting thin cells of the epidermis and the subjacent layer of the seed coat, polygonal cells with thickened, pitted walls; hairs characteristic, spreading and thickened at the base and having linear markings; endosperm tissue, the outer cells small, contents granular, the inner larger, with thickened walls; lumen irregular in size and shape. (Fig. 337.)

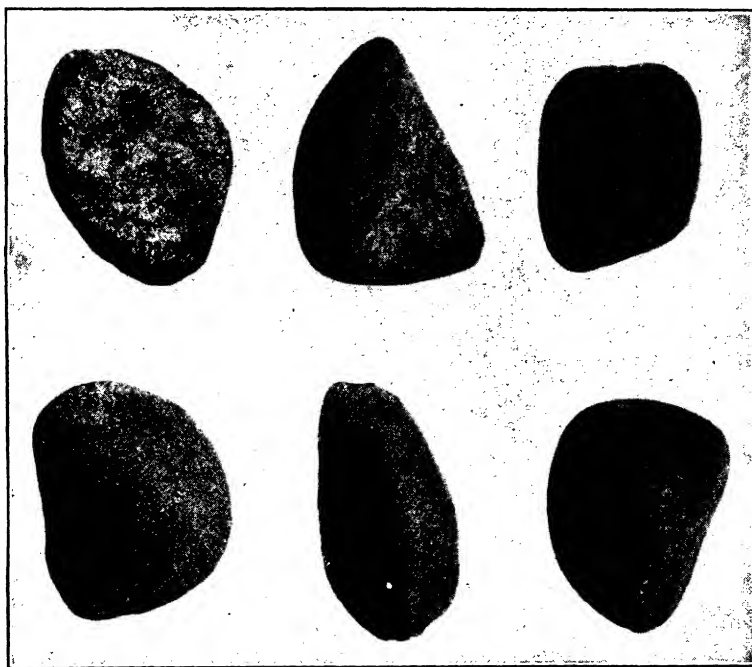


FIG. 336.—*Ignatia*.  $\times 1\frac{1}{2}$ .

**Constituents.**—From 2.5 to 3 per cent. of the alkaloids *strychnine* and *brucine*; igasuric acid, loganin, fixed oil, proteids, etc. Up to  $\frac{2}{3}$  of the total alkaloids of *Ignatia* represent strychnine.

**Uses.**—Spinal stimulant and bitter tonic. A source of Strychnine.

**Average Dose.**—0.1 Gm. ( $1\frac{1}{2}$  grains).

#### STRYCHNINA N.F. (STRYCHNINE)



**Strychnine** is an alkaloid obtained chiefly from *Nux Vomica* and also obtainable from other seeds and plants of the genus *Strychnos* (Fam. *Loganiaceæ*).

It was discovered in 1818 by the French pharmacists Pelletier and Caventou in *Ignatia*. The same pharmacists discovered brucine in 1819.

It occurs as colorless, transparent, prismatic crystals or as a white powder without odor but with a persistently bitter taste.

**Color Tests for Identity:** 1. Add a small fragment of potassium dichromate to a solution of 50 mg. of strychnine in 1 cc. of sulfuric acid. A deep blue color is produced which changes immediately to deep violet, then to purplish-red, cherry red, and finally to orange or yellow. 2. Sulfuric acid containing 1 per cent. of ammonium vanadate produces with strychnine a deep violet blue color, changing to a deep purple, and finally to cherry red.

**Distinction from Brucine.**—One cc. of a mixture of equal volumes of nitric acid and distilled water added to about 0.1 Gm. of Strychnine may produce a yellow, but not a pink or red color.

**Uses:** As a poison for rats and mice, in the manufacture of salts of strychnine including strychnine nitrate and strychnine phosphate, etc., and as an ingredient in a number of galenicals.

**Average Dose.**—1.5 mg. ( $\frac{1}{40}$  grain).

**N.F. Preparations.**—Aloin, Strychnine, Belladonna and Cascara Pills (1 pill); Aloin, Strychnine, Belladonna and Ipecac Pills (1 pill); Aloin, Strychnine and Belladonna Pills (1 pill); Compound Hypophosphites Syrup, 8 cc. (2 fl. dr.).

**Strychnine Sulfate, U.S.P. (Strychninæ Sulfas)**  $C_{21}H_{22}O_2N_2 \cdot H_2SO_4 \cdot 5H_2O$ . Av. Dose, 2 mg. ( $\frac{1}{30}$  grain). **Preparations.**—Strychnine Sulfate Tablets, U.S.P., Iron, Quinine and Strychnine Elixir, N.F., 4 cc. (1 fl. dr.), Nux Vomica Alkaloids Solution, N.F., Horses and Cattle, 2 to 4 cc. ( $\frac{1}{2}$  to 1 fl. dr.); Sheep and Swine, 0.5 to 1 cc. (8 to 15 minims).

**Strychninæ Nitras, N.F. (Strychnine Nitrate)**  $C_{21}H_{22}O_2N_2 \cdot HNO_3$ . Av. Dose, 2 mg. ( $\frac{1}{30}$  grain). **Preparations.**—Strychnine Nitrate Tablets, N.F., Compound Glycerophosphates Elixir, N.F., 8 cc. (2 fl. dr.).

**Strychninæ Phosphas, N.F. (Strychnine Phosphate)**  $C_{21}H_{22}O_2N_2 \cdot H_3PO_4 \cdot 2H_2O$ . Av. Dose, 2 mg. ( $\frac{1}{30}$  grain). **Preparation.**—Iron, Quinine and Strychnine Phosphates Elixir, N.F., 4 cc. (1 fl. dr.).

**Uses.**—Strychnine salts are used as tonics and bitters in convalescence from acute illnesses, in atonic conditions of the stomach, intestines, bladder, in alcoholism and narcotic poisoning, in diminished vision, in poisoning by chloral hydrate and ether, in sexual impotency, in certain nervous diseases, etc. They are spinal and circulatory stimulants.

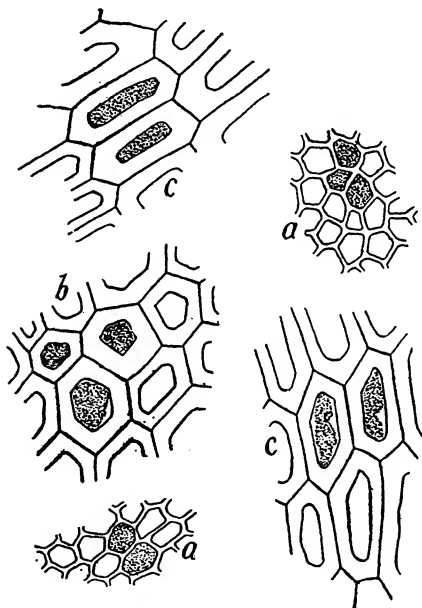


FIG. 337.—Powdered Ignatia. (a) Epidermal cells, vertical view; (b) endosperm; (c) endosperm. (Schneider.)

**Poisoning by Strychnine, Nux Vomica and Ignatia.**—Some persons, even, then idiosyncrasy to even therapeutic doses of these drugs, becoming uneasy reflex irritability which is followed by muscular twitching and later by a feeling of stiffness in the muscles of the fingers, legs and face. For these, the drug should be discontinued and a barbiturate or bromide administered.

In more serious cases of poisoning, occasioned by the ingestion of large amounts of these drugs or their preparations, the symptoms are as follows: There is an intense itching, followed by spasm of the larynx and then by general tonic and clonic (intermittent) spasms. The arms, legs and back become extended, the head is thrown back and the patient rests on his hands and feet from the extensor muscles overcoming the flexors (*opisthotonos*). The eyes are staring and the face shows a hideous grin (*risus sardonius*), the latter owing to the contraction of the facial muscles. An interim ensues when, suddenly, the convulsions commence again and there follows an alternation of convulsions and remissions. During the remissions there is complete relaxation and a cold sweat. With each successive spasm the symptoms become more violent. The slightest stimulus will provoke a convulsion. Cyanosis appears in consequence of interference with respiration; the pupils become dilated, the jaws set and death follows from asphyxia.

**Treatment.**—Administer either activated charcoal, iodoform solution or tannic acid and wash out the stomach. Give a spinal cord sedative such as phenobarbital or bromide by mouth or rectum. Administer oxygen by inhalation and artificial respiration. Catheterize the bladder to remove and prevent reabsorption of strychnine.

#### BRUCINE SULFATE N.F. (BRUCINÆ SULFAS)

**Brucine sulfate** ( $C_{23}H_{26}O_4N_2$ ) $\cdot$  $2H_2SO_4$  $\cdot$  $7H_2O$ ) is the sulfate of an alkaloid found in *Nux Vomica* and other plants of the genus *Strychnos*. It occurs as white crystals or powder, is odorless and has a very bitter taste.

**Color Test for Identity.**—When about 10 mg. of brucine sulfate are added to a few drops of nitric acid, a blood-red color is produced. When this red solution is diluted with a few drops of water and several drops of stannous chloride T.S. are added, a reddish purple color is produced.

**Uses.**—As a simple bitter and in 5 per cent solution as a local anodyne in inflammations of the external ear and in pruritus.

**Average Dose.**—2 mg. ( $\frac{1}{30}$  grain).

**Preparation.**—*Nux Vomica* Alkaloids Solution, N.F.

#### GENTIANACEÆ (GENTIAN FAMILY)

Herbs, often low-growing and containing bitter principles. Roots and short stems sometimes more or less thickened (*Gentiana lutea*). Interxylary and intraxylary phloem occurs in some of the genera. Pith bundles have been observed in *Gentiana*. The medullary rays are narrow and in some roots entirely absent. Leaves opposite, decussate, entire, exstipulate. Inflorescence cymose (*Gentiana lutea*) or condensing to a single, solitary, terminal flower (*Gentiana verna*, *G. acaulis*, etc.). Flowers regular, perfect, pentamerous or tetramerous,



sepals five to four, green, more or less synsepalous, not infrequently everted or reflexed, corolla of five, rarely four petals, more or less synpetalous, in shape passing from open-stellate, as in *Gentiana lutea*, through many stages of connation to long-tubed as in *Gentiana acaulis*; stamens five, epipetalous; pistil bicarpellate; ovary one-celled or incompletely two-celled; style more or less elongated with bilobed to divided stigma. Fruit a capsule. Seeds albuminous.

#### GENTIAN U.S.P. (GENTIANA)

**Synonyms.**—*Gentian Root*, Bitter Root, Yellow Gentian Root, Felwort; *Ger. Bitterwurz*el, *Enzianwurz*el; *Fr. Racine de Gentiane* jaune.

**Botanical Origin.**—*Gentiana lutea* Linné.

**Part Used.**—The dried rhizome and roots. The fresh root (H.P.).

**Standard of Assay.**—Gentian yields not less than 30 per cent. of water soluble extractive.

**Limit of Impurities.**—Not more than 15 per cent. of moisture, and not more than 2 per cent. of foreign organic matter.

**Habitat.**—Mountainous regions of central and southern Europe.

**Plant.**—A perennial herb growing to the height of about 1 m. with erect rhizome, thick, hollow aerial stem bearing large, opposite, 5 to 7 nerved, ovate leaves and axillary cymes of orange-yellow open-stellate flowers. The fruit is an ovate capsule containing winged seeds.

**Production and Commerce.**—The rhizomes and roots are dug up in autumn, the thick fleshy parts occasionally longitudinally sliced and the slender rhizomes and roots cut into segments of variable length. The drug is then slowly dried, during which it develops its characteristic odor, internal color and taste. During the drying process the internal color changes from white to yellowish-brown and much of the gentiopicroin disappears, being hydrolyzed by an enzyme into gentiogenin and dextrose.

It is packed in burlap bales and bags for shipment. Most of our commercial supplies are imported from France, Yugoslavia and Italy. During 1947, these countries shipped 108,057 lbs. to the United States. The chief cause of inferiority is moldiness.

**Cultivation.**—Gentian seeds are slow in germination, seedlings frequently taking several years or more to appear after the seeds are sown. Seeds should be planted in woodland soil rich in humus and the soil kept watered during periods of drought. The young plants should be set about 1½ ft. apart and in a shaded area.

**Description.**—In subcylindrical, often branched segments, rarely as entire roots or rhizomes of variable length and 5 to 40 mm. in thickness; externally moderate brown to weak brown, the rhizome vertical, annulate from leaf bases, the rhizomes and roots deeply longitudinally wrinkled and sometimes twisted; fracture short and brittle, when dry, but drug tough and flexible when damp; internally yellowish-brown to dusky yellowish-orange, exhibiting a bark from 0.5 to 2.5 mm. in thickness and yellowish-brown, a dark cambium, a wood somewhat radiate in the region just below the cambium, and, in the rhizome, a

yellowish-brown pith; odor strong and characteristic; taste at first sweet, then strongly and persistently bitter.

**Histology.**—Transverse sections of the *root* show a narrow zone of about 4 to 6 layers of thin-walled cork cells, a cork cambium, a broad zone of secondary cortex with brown, thin-walled parenchyma cells, practically devoid of starch, but containing oil globules and minute acicular crystals; a narrow zone of phloem composed of many layers of collapsed phloem parenchyma and numerous strands of sieve tubes, a distinct cambium and a broad xylem, the latter



FIG. 338.—Gentian. Portions of rhizomes and roots which constitute the crude drug. Note that the rhizome is annulated while the root is deeply longitudinally wrinkled and twisted. Broken rhizome is shown in upper left hand corner.  $\times \frac{1}{2}$ .

composed largely of yellowish brown to yellow, thin-walled wood parenchyma, scattered through which are a few large tracheæ and some tracheids which are isolated or in small groups. The medullary rays are indistinct. Transverse sections of the *rhizome* exhibit a similar structure except for islets of sieve tissue in the xylem, a central pith and a collenchymatous phelloderm. Longitudinal sections of both rhizome and root exhibit reticulate and scalariform tracheæ and tracheids with non-lignified walls.

**Powdered Drug.**—Moderate yellowish-brown to yellowish-orange. Fragments of reticulate, scalariform and porous tracheæ and tracheids, fragments of brownish cork tissue, adhering to which are frequently thick-walled cells, numerous somewhat collapsed, large parenchyma cells; occasional clumps of minute slender prismatic crystals of calcium oxalate in angles of parenchyma cells; starch grains few or absent. Stone cells and fibers are absent.

When powdered gentian is microsublimed, it yields pale yellow acicular crystals insoluble in water, alcohol or ether, but soluble in chloral hydrate and potassium hydroxide solutions. The crystals are mostly from 10 to 150 $\mu$  in length, isolated or in clusters.

**Constituents.**—The bitter crystalline glucoside, *gentiopicrin*, some of which disappears during the curing of the drug; the glucosides *gentiamarin* (amorphous) and gentianin (crystalline); gentisin, gentianose, glucose, pectin, etc.

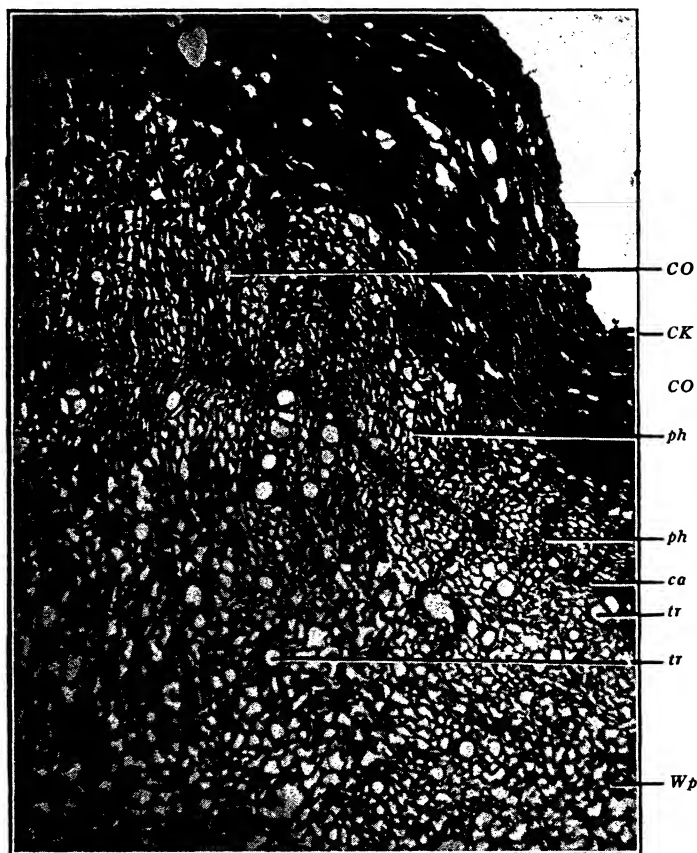


FIG. 339.—*Gentiana lutea*. Photomicrograph of a representative portion of a cross section of the root. *ck*, cork; *co*, secondary cortex; *ph*, phloem; *ca*, cambium; *tr*, tracheae; *wp*, wood parenchyma.  $\times 35$ .

**Use.**—Simple bitter.

**Average Dose.**—1 Gm. (15 grains).

**Preparation.**—Compound Gentian Tincture, U.S.P., 4 cc.; Gentian Fluid-extract, N.F., 1 cc. (enters into Gentian Elixir and Glycerinated Gentian Elixir, both N.F.); Gentian Extract, N.F., 0.5 Gm. (7½ grains).

**Adulterants.**—(1) The rhizomes and roots of other European species of the genus *Gentiana*, particularly *G. purpurea*, *G. punctata* and *G. pannonica*. All

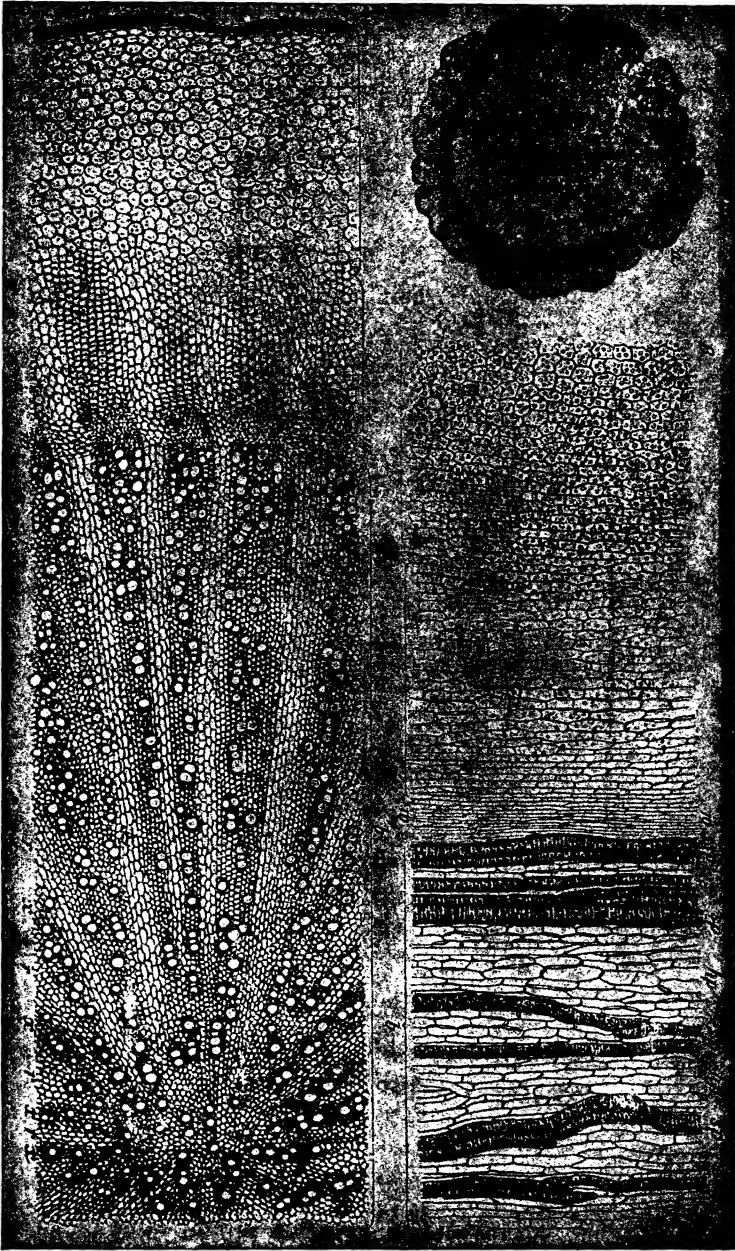


FIG. 340.—*Gentiana* sp. (not *G. lutea*). A, Transverse section of root,  $\times 2$ . B, Longitudinal-radial section of root from the center of cortex to within part of the xylem,  $\times 100$ . C, Transverse section of root from cork to center of xylem,  $\times 65$ . a, bark; b, xylem; hp, wood parenchyma; o, cortex; v, phloem; r, medullary rays; sp, tracheæ; w, cambium; x, xylem patches. (After Berg.) In the *G. lutea* the medullary rays are not distinct.

of these are smaller than the official drug. (2) The root of *Frasera carolinensis* (American Columbo) which has a yellowish color, lacks sieve tubes in xylem, but contains gentiopicrin. (3) The rhizomes of *Rumex alpinus* which contain anthraquinone derivatives and respond to the test for these. (4) The ground drug has been adulterated with ground almond shells. This adulterant may be detected by its stone cells which show a variety of shapes and sizes with colorless to light brown contents.

#### CENTAURIUM (CENTAURY)

**Synonyms.**—Bitter Herb, Herba Centaurii Minoris, Lesser Centaury Tops; *Ger.* Tausendgoldkraut, *Fr.* Petite centaurée.



FIG. 341.—Centaurium in original bundles,  $\times \frac{1}{4}$ .

**Botanical Origin.**—*Centaurium umbellatum* Gilibert [*Erythræa Centaurium* (Linné) Persoon].

**Part Used.**—The dried flowering herb.

**Habitat.**—Europe.

**Plant.**—An annual herb growing to the height of 5 dm., much branched, with opposite, entire, ovate, obovate and lanceolate leaves, terminal compound cymes of rose-colored flowers and capsular fruits.

**Production and Commerce.**—The entire plant or the aerial portion thereof is collected in the summer after some of the fruits have been partially ripened. The plants are dried in the sun, after which they are tied in bundles. While the plant has been introduced into this country and Canada, practically all of the drug on the American market has been imported from Halle and Hamburg, Germany and Trieste.

**Description.**—Stems glabrous, slender, some 4-angled, others cylindrical and with brown ridges or wings, variable in color, sparsely leafy, having a fibrous fracture and hollow pith; leaves opposite, entire, sessile, mostly 3-nerved,

the basal leaves obovate, 2 to 5 cm. in length with obtuse apex and narrowed base, those higher up ovate to linear-lanceolate with acute apex, 2 to 3.5 cm. in length; flowers rose-colored and arranged in terminal compound cymes; calyx tubular, deeply 5-parted, the tube being short and angled; corolla salverform, the tube being nearly twice the length of the calyx, the lobes of the limb oblong or oval; stamens 5, yellow, perigynous, their anthers twisted when old; pistil bicarpellary with slender style; fruit an ovoid, two-valved capsule containing numerous small seeds; odor characteristic; taste very bitter.

**Constituents.**—*Erytaurin* (glucoside), bitter principle, volatile oil, resin, mucilage, etc.

**Use.**—Simple bitter.

**Average Dose.**—2 Gm. (30 grains).

#### CHIRATA (CHIRATA)

**Synonyms.**—Chiretta, Bitter Stick, Chirayta; *Fr.* Chirette; *Ger.* Chiretta, Ostindischer Enzian.

**Botanical Origin.**—*Swertia Chirayita* (Roxburgh) Lyons.

**Part Used.**—The dried plant.

**Habitat.**—Mountainous regions of Northern India.

**Plant.**—An annual, smooth herb attaining a height of 1 m.

**Production and Commerce.**—The plants are gathered in the fruiting condition, carefully dried and tied in bundles with bamboo strips. These are packed into small bundles or bales and imported into the United States from Calcutta.

**Description.**—It occurs as entire plants or as broken pieces thereof; stem smooth, with thin readily separable bark, up to about 1 m. in length, externally yellowish- or purplish-brown, cylindrical in basal region, quadrangular and slightly winged above, with numerous opposite, ascending branches; wood of stem porous and yellow, enclosing, in the internodal regions, a large yellowish, easily separable pith; root simple, conical with few, slender rootlets; leaves opposite, sessile, entire, ovate-lanceolate, 5-nerved, with rounded base, acuminate apex and entire margin, up to 9 cm. in length and 3 cm. in width; flowers



FIG. 342.—Chirata, tied in bundles with bamboo—the condition in which it is imported.

numerous in panicles; calyx and corolla each 4-lobed; stamens 4, perigynous; ovary unilocular with 2 parietal placentæ; style slender with 2 recurved stigmas; fruit an ovoid, yellowish-brown, unilocular, many seeded capsule; odor indistinct; taste very bitter.

**Constituents.**—*Chiratin* (a bitter glucoside), chiratogenin, ophelic acid, resin, and tannin.

**Use.**—Simple bitter.

**Average Dose.**—1 Gm. (15 grains).

**Adulterants.**—Entire plants of *Swertia angustifolia* and *Swertia pulchella* both of which are less bitter and possess little or no pith in their square stems.

#### MENYANTHES (MENYANTHES)

**Synonyms.**—Bogbean, Buckbean, Marsh Trefoil, Water Shamrock; *Ger.* Bitterklee, Wasserklee; *Fr.* Ményanthe.



FIG. 343.—*Menyanthes trifoliata*. Leaf and inflorescence.  $\times \frac{1}{11}$ .

**Botanical Origin.**—*Menyanthes trifoliata* Linné.

**Part Used.**—The dried leaves.

**Habitat.**—In shallow water and bogs of Europe, Asia and North America.

**Plant.**—A perennial herb with a thick, horizontal rhizome from which arises long petioled, trifoliate leaves, each with 3 obovate leaflets, as well as a long naked scape bearing a raceme of white or slightly reddish flowers. Each flower consists of a 5-cleft calyx, an infundibuliform, 5-cleft corolla, bearded on its upper surface, 5 stamens, a bicarpellary pistil with slender style and 2-lobed stigma. The fruit is a many seeded unilocular capsule.

**Production and Commerce.**—The leaves are collected from late April to June and dried. The commercial supplies are gathered in the U.S. and Europe from the pure species and its var. *minor* Michx.

**Description.**—Leaves usually broken, when entire, trifoliate with broad, flattened and striated petioles up to 16 cm. in length, the base of which when present is sheathed with broad membranous stipules; leaflets sessile or nearly so, each 5 to 8 cm. long, obovate in outline with obtuse or acute apex, entire or coarsely undulate margin and cuneate base, ash-green; odor indistinct; taste strongly bitter.

**Constituents.**—The glucoside *meliatin* (*menyanthin*), fatty acids, sucrose, a yellow coloring substance, etc.

**Average Dose.**—1 Gm. (15 grains).

**Use.**—Simple bitter.

#### APOCYNACEÆ (DOG BANE FAMILY)

Herbs, rarely shrubs, not infrequently clambering or climbing in habit (Climbing Dogbane). Stem and branches show bicollateral bundles. Stem, leaves and flowers have latex tubes which ramify through the cortex and mesophyll tissues. Leaves alternate, opposite or verticillate, simple, entire, deciduous or evergreen. Inflorescence cymose. Flowers regular, pentamerous, rarely tetramerous; sepals five, gamosepalous, green, rarely subpetaloid to petaloid; petals five, slightly to deeply gamopetalous, in shape varying from open tubular, stellate, to elongate tubular to elongate funnel-shaped, in color varying from greenish-yellow to white or from yellow to yellow-red to crimson to crimson-purple to nearly purple-blue; stamens five, epipetalous; pistil usually bicarpellate; ovary two-celled with central placentation; style more or less elongate with a terminal brush of hairs, knobbed or multifid; stigma a circular band or circular spur beneath terminal style swelling. Fruit two follicles (*Apocynum*, etc.), a berry, drupe, or capsule. Seeds flattened, frequently with a tuft of silky hairs at one end, albuminous. Glycosides occur in many species.

#### APOCYNUM N.F. (APOCYNUM)

**Synonyms.**—*Black Indian Hemp*, *Canada-hemp*, Canadian Hemp, Dogbane, Wild Cotton, Rheumatism Weed; *Ger.* Canadische Hanfwurzel; *Fr.* Chanvre du Canada.

**Botanical Origin.**—*Apocynum cannabinum* Linné and *A. androsæmifolium* Linné.

**Part Used.**—The dried rhizome and roots.

**Standard of Assay.**—Apocynum possesses a potency such that 0.1 Gm. of it is equivalent to not less than 2 U.S.P. XIII Digitalis Units.

**Limit of Impurities.**—Not more than 5 per cent of attached stem bases and not more than 2 per cent. of other foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—United States and Canada.

**Plants.**—*Apocynum cannabinum*, the Canadian Hemp or Hemp Dogbane, is a smooth perennial herb, occurring in gravelly and sandy soil, mostly along streams, with erect or ascending stems having opposite or sub-opposite branches, attaining a height of about 2 ft. The leaves are lance-ovate, ovate-oblong to



lanceolate, pale green, short petioled on the main stem and nearly sessile on the branches. The flowers are small greenish to greenish-white, bell-shaped and arranged in dense cymes. The fruit consists of paired slender follicles. The underground system consists of a horizontal, woody gemmiferous root (previously mistaken for the rhizome by some authors) which bears slender, branching fibrous rootlets. From this gemmiferous root lateral buds arise at intervals

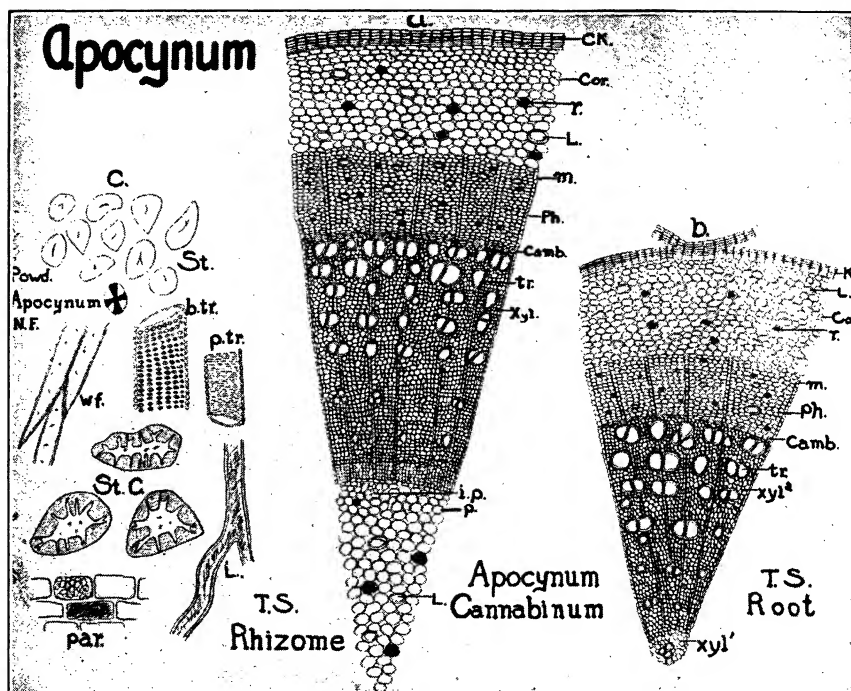


FIG. 344.—*Apocynum cannabinum*. *a*, Cross section of rhizome. *b*, Cross section of root. *c*, Powdered drug. *ck* and *k*, cork; *cor.* and *co*, cortex; *r*, resin cells; *L*, latex cells; *Ph*, phloem; *i.p.*, internal phloem; *m*, medullary ray; *camb.*, cambium; *tr.*, tracheae; *xyl*, xylem; *xyl*<sup>1</sup>, primary xylem; *xyl*<sup>2</sup>, secondary xylem; *p*, pith. *St*, starch grains; the lowermost grain showing polarization cross under polarized light; *wf*, wood fibers; *St.C.*, stone cells; *par.*, parenchyma; *b.tr.*, trachea with bordered pores; *p.tr.*, pitted trachea. [After Youngken and Vander Wyk in *Jour. Amer. Pharm. Assoc.* 28 (1939), 30.]

which form vertical rhizomes. Young gemmiferous roots are produced laterally from the vertical rhizomes. The aerial stems are continuous with the rhizomes.

*Apocynum androsæmifolium*, the Spreading Dogbane, differs from the preceding species by occurring in open woodlands and dry thickets, in possessing dichotomously branched aerial stems with chiefly alternate branches, loose cymes of pink or pinkish-white, bell-shaped flowers, the corolla of which possesses recurved lobes.

**Description.**—The drug occurs as cylindrical, sometimes branched segments of the rhizome and roots of varying length and up to 1.5 cm. in diameter;

rhizome vertical; gemmiferous root horizontal; externally reddish brown to brownish, longitudinally wrinkled, transversely fissured, the fissures having vertical sides extending through the bark; occasionally with few slender fibrous roots, buds, or root scars and purplish-brown stem bases, the last with thin, fibrous bark and hollow center; fracture short; internally bark thin and very pale orange to light yellowish-brown, up to 3 mm. thick, readily separating from

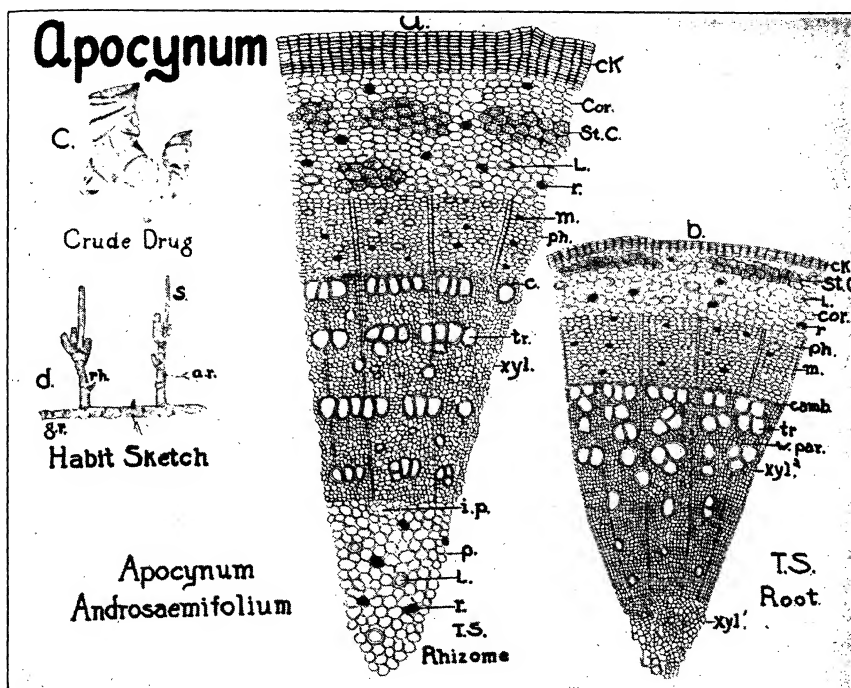


FIG. 345.—*Apocynum androsaemifolium*. *a*, Transverse section of rhizome. *b*, Transverse section of root. *c*, Piece of crude drug. *d*, Habit sketch of gemmiferous root (*g.r.*) and rhizome (*rh.*) system, the aerial stem (*s*) being a continuation of the vertical rhizome; *a.r.*, fibrous roots which spring both from the rhizome and from the horizontal gemmiferous root. *a, b*: *ck*, cork; *cor.*, cortex; *St.c.*, stone cells; *L.*, latex cells; *r.*, resin cells; *ph.*, phloem; *c.*, cambium; *m.*, medullary ray; *xyl.*, xylem; *tr.*, trachea; *i.p.*, internal phloem; *p.*, pith; *w.par.*, wood parenchyma; *xyl*<sup>1</sup>, protoxylem; *xyl*<sup>2</sup>, secondary xylem. [After Youngken and Vander Wyk in Jour. A.Ph.A., 28 (1939), 31.]

the yellowish porous and radiate wood; odor indistinct; taste bitter and acrid.

**Histology.**—Sections of rhizome and gemmiferous root exhibit the following structures:

1. *Cork* of 5 to 15 layers of tangentially elongated cells with slightly lignified walls.

2. *Cortex*, a zone of starch-bearing parenchyma, numerous thick-walled, tubular, latex cells and resin cells with a yellow resin content, the latex cells up to 240 $\mu$  in diameter in *A. cannabinum* and up to 208 $\mu$  in diameter in *A. androsaemifolium*. Groups of stone cells always occur in this region of *A.*

*androsæmifolium* but they are less frequent in *A. cannabinum*, many sections of the latter being entirely devoid of them.

3. *Phloem*, a narrow zone separated into oblong phloem patches by narrow phloem rays, the latter 1- to 3-cells wide. Each phloem strand consists of phloem parenchyma, sieve tissue and latex cells.

4. *Cambium* of meristematic cells.

5. *Xylem*, a broad zone of narrow wood wedges separated by narrow medullary rays. The wood wedges contain numerous wood fibers and large tracheæ with simple pits and bordered pores.

*Rhizome* shows in addition to the above numerous small strands of intraxylary phloem on the inner face of the xylem and a central pith composed of pith-parenchyma containing starch, resin and scattered latex cells. Stone cells may be present in the pith of *A. cannabinum* and always occur in that region of *A. androsæmifolium*. Pericyclic fibers occur in the upper part of the rhizome and throughout the aerial stems of *Apocynum*.

**Powdered Drug.**—Light yellowish-brown with a saponaceous odor; numerous starch grains up to  $20\mu$  in diameter, spherical, ellipsoidal, ovate, pyriform or irregular and showing distinct polarization crosses, sometimes altered, swollen and with a central hyaline cleft; numerous fragments of lignified porous wood fibers associated with tracheæ possessing bordered pores and simple pits; fragments of reddish-brown suberous tissue; fragments of latex and parenchyma containing latex tubes; stone cells isodiametric or elongated with strongly lignified, thick walls and branching pore canals.

**Constituents.**—The glycoside *cymarín* ( $C_{30}H_{44}O_9$ ), claimed to be the chief active principle; acetovanillone (apocynin), cynotoxin ( $C_{20}H_{28}O_6$ ), *apocynamarin* ( $C_{14}H_{18}O_3 \cdot H_2O$ ); resin, volatile oil, tannin, starch, etc.

**Uses.**—Cardiac stimulant in threatened cardiac failure, and diuretic in dropsy.

**Average Dose.**—60 mg. (1 grain).

**Preparation.**—Fluidextractum Apocyni, N.F. VII, 0.06 cc. (1 minim).

#### STROPHANTHUS N.F. (STROPHANTHUS)

**Synonyms.**—*Strophanthus Seed*; *Ger.* Strophanthussamen; *Fr.* Semence de Strophanthe.

**Botanical Origin.**—*Strophanthus Kombé* Oliver and *Strophanthus hispidus* DeCandolle.

**Part Used.**—The dried, ripe seed deprived of the awns.

**Standard of Assay.**—When assayed by the prescribed method (on frogs), *Strophanthus* possesses a potency, per gram, equivalent to not less than 55 mg. of U.S.P. Reference Ouabain.

**Habitat.**—Africa.

**Plants.**—Perennial woody climbers, whose scandent stems arise to the summits of tall trees and dangle downward in festoons. The inflorescence is a terminal cyme of cream-colored, purplish-spotted flowers, the corolla of which possesses long tailed and twisted lobes. The fruit is a thick-skinned, lance-ovate

follicle, occurring in divergent pairs. Each follicle contains numerous closely packed lance-ovoid, hairy seeds with their long awns.

**Production and Commerce.**—*Strophanthus Kombé* is native to forests of Eastern Africa (especially near the Nyanza and Tanganyika lakes and Shiré river) and yields that commercial variety of seed known as "*Green Strophanthus*." *Strophanthus hispidus* is native to forests of West Africa (Sierra Leone, Senegambia and the lower Congo district) and yields the seeds known in commerce as "*Brown Strophanthus*." The fruits are gathered when ripe, in June and July, by the natives who peel off the epicarp and mesocarp and dry the

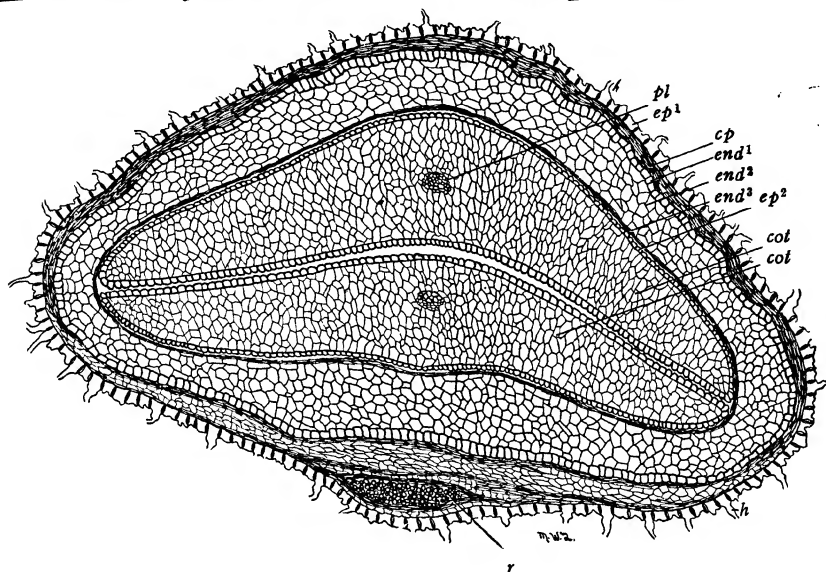


FIG. 346.—*Strophanthus*. Transverse section of the seed of *Strophanthus Kombé*.  $\times 23$ . *h*, basal portions of hairs; *ep¹*, outer epidermis of spermoderm; *cp*, collapsed parenchyma of spermoderm; *end¹*, external layer of endosperm; *end²*, reserve parenchyma of endosperm which contains strophanthin; *end³*, inner, collapsed cell layer of endosperm; *ep²*, epidermis of cotyledon; *cot*, reserve parenchyma of cotyledons; *r*, raphe. (Drawing by M. W. Quimby.)

seeds in the endocarp. The seeds are later deprived of their long awns, generally before being exported to this country. Green *Strophanthus* seeds are considered the best, since they generally contain the greater percentage of strophanthin. Most of our commercial supply of the drug is imported in bags from Portuguese East African ports.

**Description.**—Usually as entire seeds, oblong-lanceolate, somewhat compressed, with obtuse base and acute to narrowly acuminate apex; from 7 to 25 mm. in length, from 2.5 to 5 mm. in breadth and from 0.5 to 2 mm. in thickness; externally yellowish-green to pale olive when recent, light fawn brown with a greenish tinge when kept for a year or more, silky lustrous from a dense covering of appressed hairs (*S. Kombé*); or light to dark-brown, sparingly hairy with fewer and smaller hairs (*S. hispidus*), bearing on one side a distinct raphe running from the center to the summit; fracture short and soft; the broken surface

whitish and oily; odor heavy when the seeds are crushed and moistened; taste strongly bitter.

**Histology.**—Sections of Green *Strophanthus* (*S. Kombé*) seeds show the following structures, passing from periphery toward the center;

1. *Spermoderm*, consisting of outer epidermis and several layers of more or less collapsed, thin-walled cells containing only an occasional crystal of calcium oxalate. Arising from the center of the outer surface of the epidermal cell (one from a cell) are thin-walled, unicellular, usually bent, non-glandular hairs which are slightly lignified and from 200 to 800 $\mu$  in length. If sections are cut through the raphe, fibrovascular elements are visible.

2. *Endosperm* of from 9 to about 30 rows of somewhat polygonal cells with slightly thickened walls, and containing *strophanthin*, aleurone grains and globules of fixed oil. When sections are transferred from water to 80 per cent. sulfuric acid, the strophanthin gradually dissolves, imparting an olive-green to yellowish-green color to the cells containing it. This color gradually changes to blue, violet and red.

3. Two large wavy-convex *cotyledons* in the center, each showing a prominent epidermis enclosing numerous reserve parenchyma cells, each of which contains aleurone grains, oil and occasionally strophanthin. Plerome tissue extends through each cotyledon.

Sections of *S. hispidus* seeds differ from those of *S. Kombé* in showing fewer hairs, the latter arising from near the radial walls of the epidermal cells of the seed coat.

**Powdered Drug.**—Dusky yellow to light olive; taste very bitter. Numerous fragments of thin-walled, slightly lignified hairs, from 200 to 800 $\mu$  in length, in *S. Kombé*, fewer in powder of *S. hispidus*; numerous fragments of thin-walled parenchyma of endosperm and cotyledons containing small aleurone grains, starch grains up to 8 $\mu$  in diameter, fixed oil, and some strophanthin; spiral tracheæ; no appreciable amount of calcium oxalate; epidermal cells with thickened, lignified radial walls.

**Constituents.**—Up to 3 per cent. of the bitter glycoside known as *strophanthin* and *k*-strophanthin, about 30 per cent. of fixed oil, kombic acid, strophanthic acid, the alkaloids trigonelline and choline, etc. The active principle, *strophanthin* ( $C_{40}H_{66}O_{19}$ ), is soluble in water and diluted alcohol but nearly insoluble in ether, chloroform and benzene. It dissolves in sulfuric acid producing an emerald green color changing to brown.

**Uses.**—Cardiac stimulant (of digitalis group) and diuretic.

**Average Dose.**—60 mg. (1 grain).

**Preparation.**—*Strophanthus* Tincture, N.F., 0.5 cc. (8 minims).

**Adulterants.**—(1) *Strophanthus Courmontii* seeds, the most frequent adulterant of *S. Kombé* seeds, which are broadly lanceolate with a grayish-green or brown seed coat, averagely shorter, and contain numerous single and twin prismatic crystals of calcium oxalate in the seed coat. Sections mounted in 80 per cent. sulfuric acid show a series of color changes passing from light yellow through light orange, red-orange to violet and green at the edges. (2) Seeds of

*Strophanthus Nicholsonii* which are broadly lanceolate, averagely thicker, woolly with long white shaggy hairs. (3) Seeds of *Strophanthus gratus* which are somewhat spindle-shaped, compressed, brown, and exhibit short warty hairs; sections are colored pale orange to pink and red with sulfuric acid. These as well as the *Acokanthera Ouabaio* contain the crystalline glycoside, *ouabain* or *G-strophanthin*. (4) Seeds of *Kickxia Africana* which are acuminate at both ends, twisted into an S-shape, devoid of hairs, and reddish-brown in color. Their cotyledons are much folded as observed in cross sections. (5) Seed of *Strophanthus sarmentosus* which are lance-ovoid, reddish-brown to greenish with yellowish hairs; both spermoderm and cotyledons contain numerous crystal aggregates of calcium oxalate; sections are colored yellow to pale pink and bluish-violet when examined in sulfuric acid. (6) Seed of *Strophanthus Eminii* which are lanceolate, yellowish-brown and covered with yellow hairs; sections are colored brown with sulfuric acid, becoming violet.

**Strophanthin N.F. (Strophanthinum)** is a glycoside or a mixture of glycosides obtained from *Strophanthus Kombé* Oliver (Fam. *Apocynaceæ*). It occurs as a white or yellowish powder soluble in water and in diluted alcohol. It is extremely poisonous. When sulfuric acid is added to it, an emerald green color is produced. According to Windaus, Revere and Schwieger, *cymarín* and *strophanthin-β* occur in commercial *strophanthin*. It should be preserved in tight, light resistant containers. *Strophanthin* is used as a cardiac stimulant. Av. dose, intravenous, 0.5 mg. ( $\frac{1}{120}$  gr.). **Preparation.**—*Strophanthin Ampuls*, N.F. used in congestive heart failure.

*Strophanthin*, when assayed as directed on cats free of gross evidence of disease and weighing between 2.0 and 4.0 Kg., shall possess a potency per mg. equivalent to 0.5 mg. of U.S.P. *Ouabain Reference Standard*. *Strophanthin*, adjusted to conform to the specified potency, will be considered to conform to the N.F. requirement if the result of the assay does not vary more than 20 per cent from the specified potency.

**Ouabain U.S.P. (Ouabainum)**, also known as *Gratus-* or *G-Strophanthin* and *Crystallized Strophanthin*, is a glycoside obtained from the seed of *Strophanthus gratus* (Wall. et Hook.) Baillon (Fam. *Apocynaceæ*). The potency of *Ouabain*, assayed biologically, corresponds to the potency of 91 per cent of an equal weight of U.S.P. *Ouabain Reference Standard*. Its action is similar to *strophanthin* but stated to be more active when injected intramuscularly or intravenously. Average dose, 0.25 mg. ( $\frac{1}{250}$  gr.). **Preparation.**—*Ouabain Injection (Injectio Ouabaini)* U.S.P. Av. dose, intravenous, 0.25 mg. of *ouabain*. *Ouabain* is also used as a reference standard in assaying *Strophanthus* and its products. The wood of *Acokanthera Schimperi* (A.DC.) Schwf. also yields some of the drug.

#### ASPIDOSPERMA (ASPIDOSPERMA)

**Synonyms.**—Quebracho, White Quebracho, Quebracha, Quebracho Bark; *Fr.* and *Ger.* Quebracho.

**Botanical Origin.**—*Aspidosperma Quebracho-blanco* Schlechtendal.

**Part Used.**—The dried bark.

**Limit of Impurities.**—2 per cent. of wood or other foreign matter.

**Habitat.**—Argentine Republic.

**Plant.**—A stately ornamental tree with a huge trunk and large crown, found growing in Argentine Republic and adjacent countries.

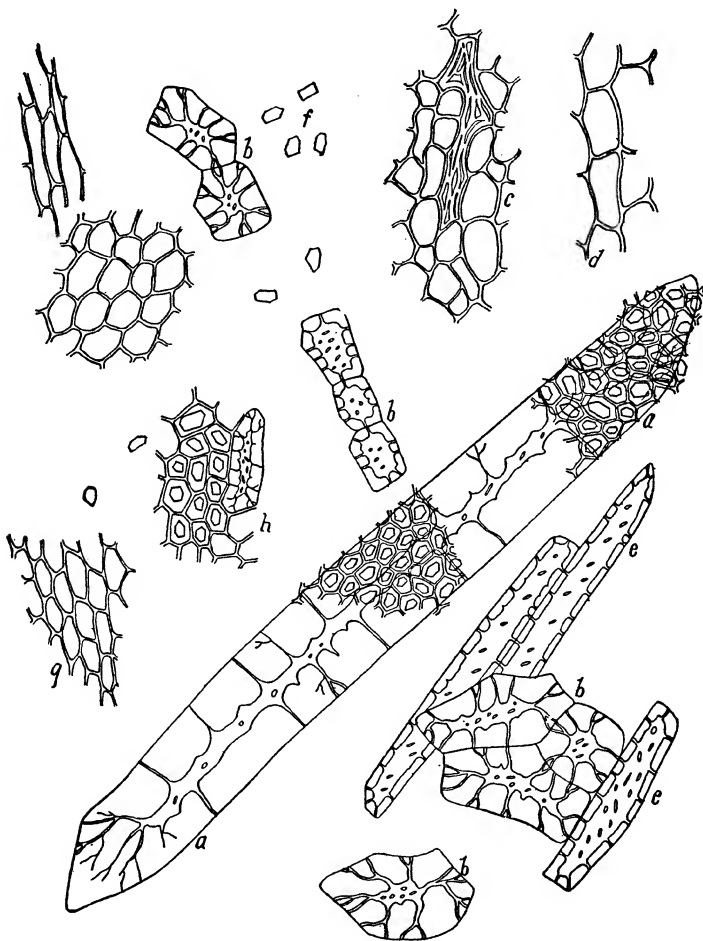


FIG. 347.—Powdered *Aspidosperma*. (a) Very large bast fiber, all lined with crystal bearing cells; (b) stone cells; (c) phloem parenchyma and sieve tubes; (d) parenchyma; (e) sclerenchymatous tracheids; (f) prismatic crystals; (g) small celled parenchyma; (h) crystal bearing parenchyma and stone cell. (Schneider.)

**Production and Commerce.**—Most of the commercial supply comes from Argentina. That country also ships large quantities of extract of the wood of *Schinopsis Lorentzii* (Griseb.) Engl. (Fam. *Anacardiaceæ*); commonly known as “*Quebracho Colorado*,” which is employed in the tanning industry.

**Description.**—The drug occurs in broken, irregular, nearly flat or partially quilled pieces usually up to 18 cm. in length, 7 cm. in breadth and 3.5 cm. in

thickness; cork layer from 3 to 25 mm. in thickness, grayish- or reddish-brown, deeply furrowed, frequently netted with shallow transverse and longitudinal fissures; outer surface, when deprived of cork, light brown or reddish-brown; inner surface pale yellowish- or reddish-brown, finely striated longitudinally, often with adhering wood; fracture short-fibrous with projecting bast fibers; odor indistinct; taste bitter and aromatic.

**Histology.**—Sections of the bark exhibit the following structural characteristics.

1. *Cork*, a very broad zone of reddish-brown cells of polygonal outline with somewhat lignified walls.

2. *Cork cambium* of meristematic cells.

3. *Cortex* consisting of a matrix of starch- and tannin-containing parenchyma cells, amongst which are scattered large groups of stone cells and sclerenchyma fibers.

4. *Phloem*, a broad zone of sieve tubes, phloem cells and companion cells separated into irregular shaped phloem patches by starch containing phloem rays, the latter being 1 to 5 cells broad. Imbedded in the phloem patches are large groups of stone cells with included bast fibers. The sclerenchyma fiber groups of both cortex and phloem are more or less surrounded by crystal fibers the cells of which contain monoclinic prisms.

The starch grains found in cortex, phloem and phloem rays, when examined in scrapings of the bark mounted in water, are found to be simple or 2- to 4-compound, the separate grains of spheroidal, plano-convex or irregular outline and up to 25 $\mu$  in diameter.

**Constituents.**—The alkaloids *aspidospermine*, *quebrachine*, *aspidospermatine*, *aspidosamine*, *quebrachamine*, and *hypoquebrachine*; tannin, the sugars quebrachite and inosite, etc.

**Uses.**—*Aspidosperma* is used as a respiratory stimulant in emphysema, dyspnoea of asthma and of chronic bronchitis.

**Average Dose.**—4 Gm. (60 grains). **Preparation.**—Fluidextract, 4 cc. (60 minims).

#### ASCLEPIADACEÆ (MILKWEED FAMILY)

Herbs, undershrubs, or shrubs sometimes climbing as *Condurango*, containing a milky juice, many species yielding rubber. Leaves entire, more or less fleshy, opposite or verticillate. Inflorescence usually a dichasial or scorpioid cyme. Flowers regular, pentamerous; sepals woolly, small, synsepalous; petals 5, rarely 4, synpetalous, elongated into awls; the corolla varying in shape from stellate to campanulate and in color from pale green to yellow, to greenish-brown, chocolate, or from white to yellow, to scarlet, to crimson, to purple, to blue; stamens five, epipetalous, fused in relation, forming a cylindrical swollen mass around the central pistil; filaments flattened and furnished with a crown having various appendages; anthers 2-celled, each cell containing a pollen mass (*pollinium*), adhering to the glandular prominences of the stigma; pistil bicarpellate; ovary 2-celled, superior. Fruit typically of 2 divergent follicles (*Asclepias*),



rarely becoming succulent or bladdery. Seeds numerous, compressed, imbricate, with a comose appendage.

### ASCLEPIAS (ASCLEPIAS)

**Synonyms.**—*Pleurisy Root*, Orange Milk Weed Root, Butterfly Weed Root; *Ger.* Knollige Schwalbenwurzel; *Fr.* Racine d'asclépiade tubéreuse.

**Botanical Origin.**—*Asclepias tuberosa* Linné.

**Part Used.**—The dried root.

**Limit of Impurities.**—5 per cent. of foreign organic matter (N.F. V).

**Habitat.**—United States.

**Plant.**—A perennial herb with erect, hirsute stem frequently branched near the summit. Leaves alternate, sessile or short petiolate, lanceolate or oblong-lanceolate with acute or obtuse apex and rounded or cordate base. Inflorescences terminal cymes of many flowered umbels, the peduncles of which are shorter than the leaves. Calyx small and 5 parted; corolla deeply 5 parted, the segments greenish orange; corona of 5 erect, oblong, orange hoods, each bearing a filiform horn; stamens with filaments united to form a tube and winged anthers; stigma flat, 5 lobed. The fruit consists of finely hairy, acuminate follicles, each containing numerous seeds.

**Description.**—It occurs as entire fusiform roots up to 25 cm. in length and up to 5 cm. in diameter or as transverse segments or longitudinal slices of variable length; externally orange-brown or grayish-brown, longitudinally furrowed, annulate in upper region, the crown with short, hollow stem bases and circular or elliptical scars; fracture of thicker parts, tough and uneven, of thinner parts short; inner surface whitish and showing many cavities; odor indistinct; taste starchy, bitter and acrid.

**Histology.**—Transverse sections of the root show the following microscopic structures, passing from periphery toward the center.

1. *Cork*, of tangentially-elongated, slightly lignified cells.
2. *Phellogen*, of meristematic cells.
3. *Secondary Cortex*, a broad zone of parenchyma cells, some of which contain starch grains, others rosette aggregates of calcium oxalate. In the outer region of this zone occurs a closed band of stone cells, each of which has thick, lignified walls and branching pores.
4. *Phloem*, of narrow phloem patches separated by phloem portions of medullary rays.
5. *Cambium*, of more or less collapsed meristematic cells.
6. *Xylem*, a broad zone of xylem patches composed mostly of starch- and crystal-containing wood parenchyma and wood fibers, scattered amongst which are a few broad porous and scalariform tracheæ. Separating the xylem patches from each other are broad medullary rays, the cells of which are thin-walled and contain starch.

Scrapings of the fractured surface of the drug, when mounted in water, show that the starch grains are simple or 2- to many-compound, the individual grains being spheroidal, polyhedral or plano-convex, with a central hilum and up to

15 $\mu$  in diameter. The calcium oxalate crystals will be noted in the form of rosettes up to 50 $\mu$  in diameter.

**Constituents.**—The glucoside, *asclepiadin*; resins, volatile oil, tannin, fixed oil, gum, calcium oxalate, etc.

**Uses.**—Pleurisy root is used as a diaphoretic, diuretic, expectorant and alterative.

**Average Dose.**—2 Gm. (30 grains).



FIG. 348.—*Asclepias tuberosa*.

**Adulterants.**—Rhizomes and roots of other species of *Asclepias* which differ from Pleurisy Root by possessing latex cells and contents.

#### CONDURANGO (CONDURANGO)

**Synonym.**—Condurango Bark, Eagle-vine Bark, Condor-vine Bark; *Ger.* Kondurangorinde; *Fr.* Écorce de condurango.

**Botanical Origin.**—*Marsdenia Cundurango* Reichenbach filius.

**Part Used.**—The dried bark.

**Purity Rubric.**—Not more than 2 per cent. of adhering wood and not more than 1 per cent. of other foreign organic matter, it yields not more than 2 per cent. of acid insoluble ash. N.F. VII.

**Habitat.**—Ecuador.

**Commercial Source.**—Colon and Cristobal.

**Plant.**—A climbing vine growing in various parts of South America.

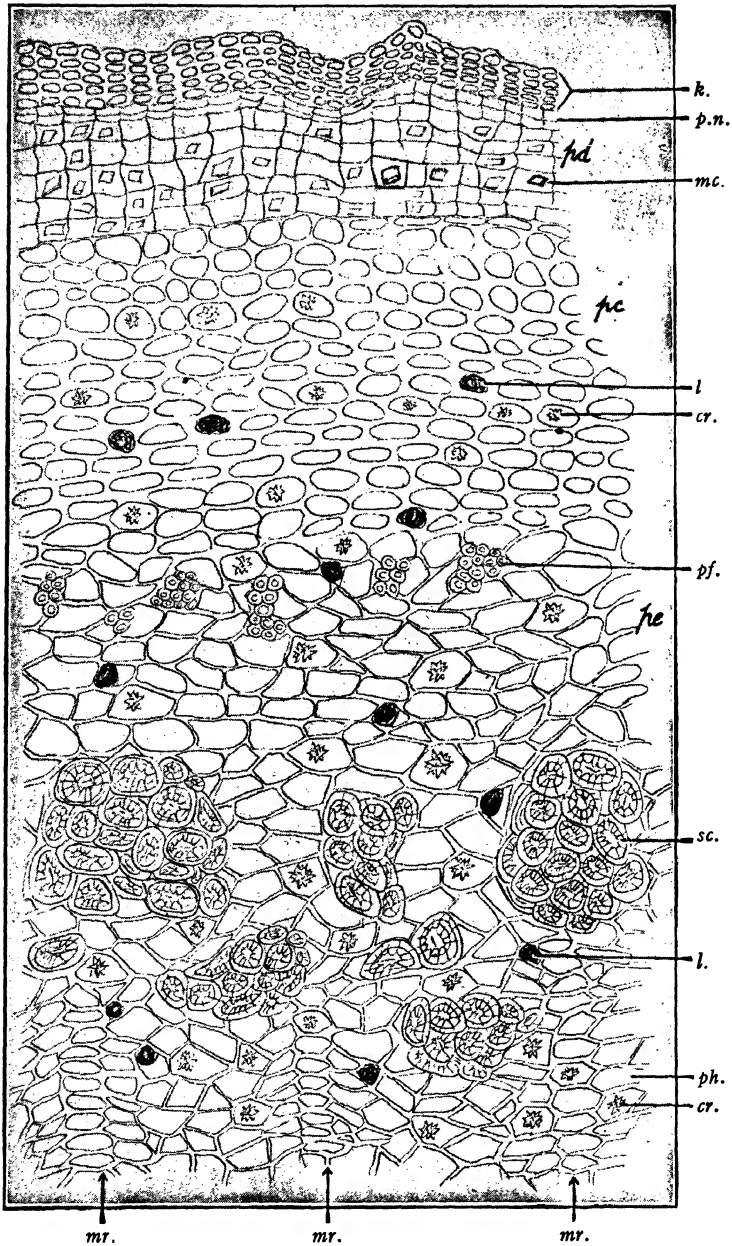


FIG. 349.—Condurango. Transverse section of drug showing *k.*, cork; *pn.*, phellogen; *pd.*, phelloderm; *mc.*, membrane crystals; *pc.*, primary cortex; *l.*, latex cells; *cr.*, rosette aggregate crystals of calcium oxalate; *pe.*, pericycle; *pf.*, pericyclic fibers; *sc.*, stone cells; *ph.*, phloem; *mr.*, medullary rays.

**Description.**—In quills or transversely curved pieces up to 13.5 cm. in length and from 1 to 7 mm. in thickness; outer surface pale brown to dark-brown, nearly smooth and with numerous lenticels, or more or less scaly and rough, the scales rough; inner surface finely longitudinally striated, pale brown to weak yellowish-orange; fracture short-fibrous in the outer portion and granular in the inner portion; odor indistinct to slightly aromatic; taste aromatic and bitter.

**Histology.**—1. *Cork* of several layers of suberized cells, occasionally lignified and having yellowish-brown contents.

2. *Secondary cortex (Phelloderm)* of about 10 layers of parenchyma cells, some containing simple or 2- to 4-compound starch grains, others prismatic membrane crystals.

3. *Primary cortex*, some of the cells of which contain the characteristic starch grains noted above, others rosette aggregates of calcium oxalate. Scattered here and there are large groups of stone cells.

4. *Pericycle* of tangentially-elongated parenchyma in which are arranged latex cells and groups of thick-walled, non-lignified to very slightly lignified sclerenchyma fibers.

5. *Phloem* of numerous phloem masses separated by narrow medullary-rays, 1 to 2 cells wide. Each phloem patch contains small groups of sieve tubes and companion cells also phloem parenchyma containing either starch or rosettes of calcium oxalate as well as numerous latex cells, few or no bast fibers and large groups of stone cells.

**Powdered Drug.**—Pale brown to light yellowish-brown; numerous groups of stone cells, the individual cells irregular with very thick porous yellow walls, the lumina usually containing air, parenchyma containing rosette aggregates (up to  $40\mu$  in diameter) and single prisms (up to  $35\mu$  in length) of calcium oxalate as well as starch grains; starch grains simple or 2- to 4-compound, the individual grains from 3 to  $20\mu$  in diameter; fragments of long non-lignified sclerenchyma fibers; fragments of latex tubes containing a granular substance; fragments of yellow to reddish-orange cork tissue.

**Constituents.**—The glycosides *alpha-condurangin* and *beta-condurangin*, a sterol-like substance called *conduransterin*; *conduritol*, a tetrahydroxy-cyclohexane, resin, fixed oil, tannin, starch, etc.

**Use.**—Aromatic bitter.

**Average Dose.**—4 Gm. (60 grains).

**Preparation.**—Fluidextractum Condurango, 4 cc. (1 fl. dr.).

## CONVOLVULACEÆ (MORNING GLORY FAMILY)

Chiefly twining perennial or annual herbs, more rarely, as in some tropical species, shrubs or trees. Underground parts sometimes swollen into tuberous roots (Jalap, Scammony, Sweet Potato, Wild Man of the Earth). Stems rarely short, upright or tufted, usually elongate and circumnutating in action. Vascular bundles of stems and leaves frequently bicollateral. Leaves alternate, mostly simple, exstipulate, varying from cordate to cordate-sagittal, to broad

reniform, to reniform and palmately-lobed to palmatifid to palmately-compound (*Ipomæa* shows all these transitions). Stem and leaves frequently contain a dull, viscous, watery to milky-white juice. Inflorescence a scorpioid cyme, becoming reduced in some forms to a solitary, axillary flower. Flowers regular, perfect and pentamerous; sepals five, green, gamosepalous; corolla gamopetalous, varying in shape from rotate to funnelform, campanulate or tubular with expanded mouth, in color from greenish, yellow to white or through yellowish-pink to scarlet, crimson, purple or blue; stamens five, often with the bases of the filaments expanded; pistil bicarpellate; ovary 1- to 4-celled, superior, often surrounded by a nectar girdle; style filiform with bilobed or bifid stigma. Fruit usually a capsule (*Ipomæa*, *Exogonium*, etc.), dehiscent septifragally, rarely a berry. Seeds scantily albuminous to exalbuminous with a more or less curved embryo. Purgative glucosidal resins occur in many species.

#### JALAPA N.F. (JALAP)

**Synonyms.**—*Radix Jalapæ*, *Jalap Root*, Vera Cruz Jalap; *Ger.* Jalapenwurzel, Jalapenkollen; *Fr.* Jalap tubéreux.

**Botanical Origin.**—*Exogonium purga* (Wenderoth) Benth.

**Part Used.**—Dried tuberous root.

**Standard of Assay.**—Not less than 9 per cent. of the total resins of Jalap.

**Ash.**—Not more than 0.5 per cent. acid-insoluble.

**Habitat.**—In moist, rich woodlands of Eastern Mexico.

**Plant.**—A perennial twining herb whose underground portion consists of a tuberous root system. Its aerial portion consists of many slender, furrowed, purplish, twining stems which may attain a length of 5 or 6 m. These bear alternate, long petioled, exstipulate, cordate, entire leaves and 3-flowered cymes of purple, salver shaped flowers. The fruit is a septifragally dehiscent capsule.

**Production and Commerce.**—The plant grows wild in rich woodland soil at an elevation of from 5,000 to 8,000 feet in Eastern Mexico. It is extensively cultivated in the vicinity of Jalapa, Mexico, in the Neilgherry mountains of India, and grown to some extent in Jamaica. The roots are gathered at various seasons of the year. The best time for gathering is the fall. They are washed, placed in nets and dried over fires which gives them a smoky odor. The largest roots are longitudinally sliced before drying. The drug is placed in bags for shipment. During recent years the drug has been imported wholly from Vera Cruz and Mexico City, Mexico.

**Description.**—The tuberous roots occur either in the entire or cut condition. The entire roots are either fusiform, globular, ovoid, or pyriform (pear-shaped), the upper end being somewhat rounded, the lower slightly tapering; from 4 to 15 cm. in height and from 1 to 10 cm. in diameter; externally dusky brown to moderate yellowish-brown, longitudinally wrinkled or furrowed and with numerous lenticels; hard, compact and resinous; when broken, internally pale brown, horny or waxy, exhibiting a distinct dark primary cambium line and mottled wood containing numerous bundles and brown resin cells; odor distinct, smoky; taste sweet and acrid.



FIG. 350.—*Exogonium purga*. 1. Portion of stem bearing flowers and leaves. 2. Vertical- and 3. Transverse section of ovary. 4. Stigma. 5. Base of stem and tuberous roots. (After Bentley and Trimen.)

**Histology.**—Transverse sections, cleared in potassium hydroxide solution, exhibit the following structural peculiarities, passing from periphery toward the center.

1. *Cork*, a zone of numerous layers of thin-walled cork cells with brownish contents.

2. *Cork cambium*.

3. *Cortex*, a narrow zone of more or less tangentially-elongated starch containing cells, scattered amongst which will be noted secretory cells with yellowish-brown resin content.



FIG. 351.—Jalap tubers.  $\times \frac{2}{3}$ .

4. *Primary cambium*, on the outer surface of which will be noted small groups of sieve elements and on the inner surface interrupted groups of tracheæ.

5. *A broad central zone* of starch-bearing parenchyma imbedded in which are interrupted concentric zones of numerous small bicollateral bundles developed from secondary cambia, and numerous secretory cells with yellowish-brown resin contents.

**Powdered Drug.**—Light yellowish-brown; odor distinctive and smoky; starch grains numerous, single or 2- to 3-compound, often swollen, ellipsoidal or ovoid with concentric or excentric lamellæ and radiating or crescentic clefts, from 3 to 35 $\mu$  in diameter; calcium oxalate in rosette aggregates from 10 to 36 $\mu$  in diameter; tracheæ short, broad with elliptical-shaped bordered pores or with simple pores; secretory cells with yellowish-brown resinous contents; fragments of brown resinous masses; few sclerenchyma fibers with thick walls.

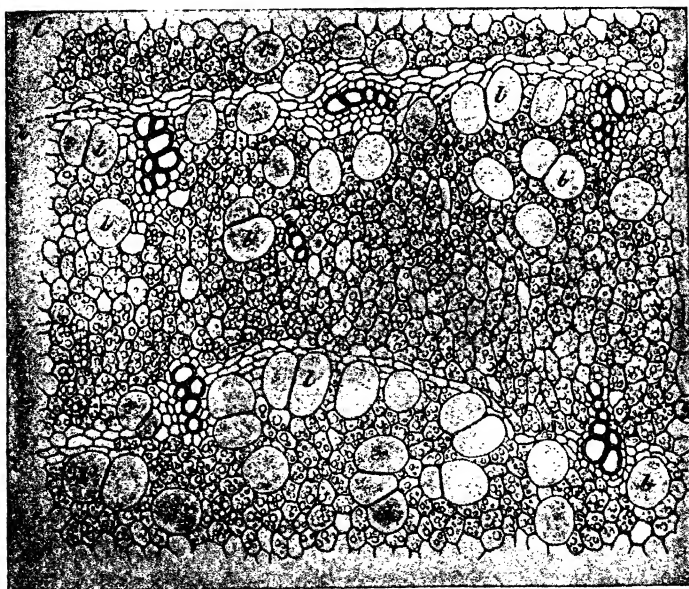
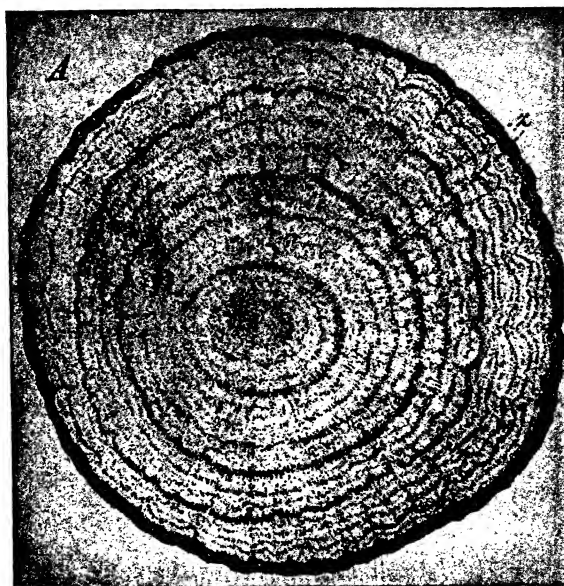


FIG. 352.—Jalap. A, Transverse section (nat. size). C, Segment of A through 2 secondary cambium zones,  $\times 65$ . z, secondary cambia; t, starch parenchyma; l, resin cells; y, fibro-vascular bundles. (After Berg.)



**Constituents.**—The resins *convolvulin* (insoluble in ether but soluble in alkaline solutions) and *jalapin* (soluble in ether and alkalis); volatile oil, gum, starch, calcium oxalate and sugar.

**Uses.**—Hydragogue cathartic, emmenagogue, and source of Resina Jalapæ N.F. Jalap and other drastic purgatives should not be administered to persons suffering from nephritis, inflammation of the intestines, hemorrhoids, senile

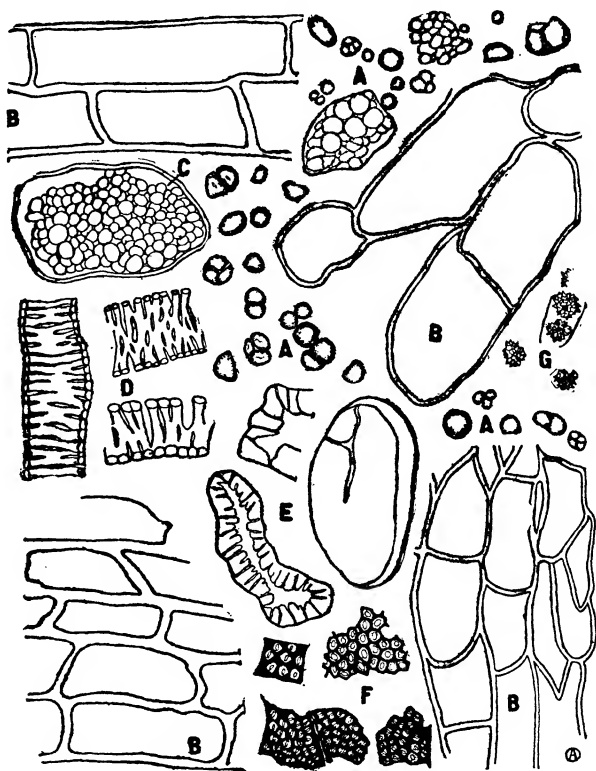


FIG. 353.—Powdered Jalap,  $\times 183$ . A, Starch grains. B, Parenchyma cells. C, Parenchyma cells filled with starch. D, Tracheae. E, Stone cells. F, Fragments of tracheae with bordered pores. G, Rosette aggregates of calcium oxalate. (After Sayre.)

debility or during menstruation or pregnancy, because of their irritant and depressing action.

**Average Dose.**—1 Gm. (15 grains).

**N.F. Preparations.**—Compound Jalap Powder, 2 Gm. (30 grains); Jalap Resin, 0.125 Gm. (2 gr.); Jalap Resin enters into Compound Colocynth and Jalap Pills (*Vegetable Cathartic Pills*) (1 pill) and Compound Mild Mercurous Chloride Pills (*Compound Cathartic Pills*) (2 pills).

**Substitute.**—The tuberous roots of *Mirabilis Jalapa* L. (Fam. *Nyctaginaceæ*), the Four O'clock or Marvel of Peru, have recently entered this country from Mexico in the form of dried transverse segments, the cut surfaces of which are dirty white to pale brown and show concentric circles of bundles. The entire

roots of this species are dark brown, conical, either single or clustered and possess a hard, complete and horny fracture. The substitute may be distinguished from Jalap by its non-lignified cork, numerous raphides of calcium oxalate, by the starch grains which are simple, 2- to 8-compound and in spheroidal or oval aggregates, the individual grains polygonal, plano-convex and angular-convex with a central, cleft hilum, up to  $12\mu$  in diameter and further by its absence of rosette aggregate crystals of calcium oxalate, bordered pored tracheæ, lignified fibers and stone cells. In powdered form this substitute possesses a distinct odor, a slightly acrid taste which is followed by a tingling, warm and numbing sensation in the mouth, and a sialagogue action. It contains 2.78 per cent of resin. The powdered root is an irritant to the skin and mucosa. (For further details, see Youngken, *Jour. A.Ph.A.* 29 (1940), 62.)

**Adulterants.**—The root of *Piptostegia Pisonis* Mart. (Fam. *Convolvulaceæ*) known as “*Piptostegia Root*” and “*Brazilian Jalap*” has for the past 17 years appeared in the American and European markets. It occurs in transverse, circular or oval sections, varying from about 2.5 to 8 cm. in diameter and from about 0.3 to 0.6 or 0.8 cm. in thickness, its cut surface pale yellowish-brown, marked with several concentric cambium rings and many resin dots. It somewhat resembles Poke, Mexican Scammony and Bryonia roots. Farwell (*Jour. A. Ph. A.*, Vol. vii, No. 10, p. 854) described its histology.

This drug contains about 20 per cent. of resin which is mostly insoluble in ether.

**Male or Orizaba Jalap** (Mexican Scammony) consists of the tuberous roots of *Ipomæa orizabensis* Lendenio, a plant growing in Mexico. This substitute for Jalap has also been used to adulterate Levant Scammony and in numerous instances has been substituted for the latter. When found as an adulterant for Jalap it occurs as entire fusiform roots or long segments of these. These are light to dark brown externally, deeply wrinkled with a tough fibrous fracture exposing a light brown inner surface which shows numerous alternating rings of fibrovascular tissue and parenchyma containing latex tubes with brownish contents. It contains averagely from 12 to 22 per cent. of resin of which about 65 per cent. is ether-soluble.

**Allied Drugs.**—**Indian Jalap**, or **Turpeth Root** represents the dried root and stem of *Ipomæa Turpethum* R. Br., a convolvulaceous plant native to India, the Malay Archipelago and Northern Australia. It occurs in pieces of varying dimensions of a dull grayish or brownish color and longitudinally furrowed and wrinkled, frequently with the bark slit on one side and deprived on the central portion. Its fracture is short and its taste nauseous. It contains up to 10 per cent. of total resins. One of these is ether-soluble and consists of a mixture of  $\alpha$ - and  $\beta$ -turpethin, the second is ether-insoluble and called turpethin. Purgative. Average Dose, 1 Gm. (15 grains).

**Resina Drastica** from an unidentified Mexican plant probably belonging to the *Convolvulaceæ* somewhat resembles Brazilian Jalap and Orizaba Jalap. It differs from both of these by having no rosette crystals and in yielding a lemon yellow colored resin, the latter present to the extent of 19 per cent.

## IPOMEA N.F. (IPOMŒA)

**Synonyms.**—*Orizaba Jalap*, *Mexican Scammony*, Male Jalap Root.

**Botanical Origin.**—*Ipomœa orizabensis* Ledenois.

**Part Used.**—The dried root.

**Standards.**—Not less than 15 per cent. of the total resins of *Ipomea* and not more than 3 per cent. of acid-insoluble ash.

**Habitat.**—Mexico.

**Plant.**—A climbing perennial vine whose underground portion consists of a large fusiform, somewhat branching, yellowish root which when freshly gathered

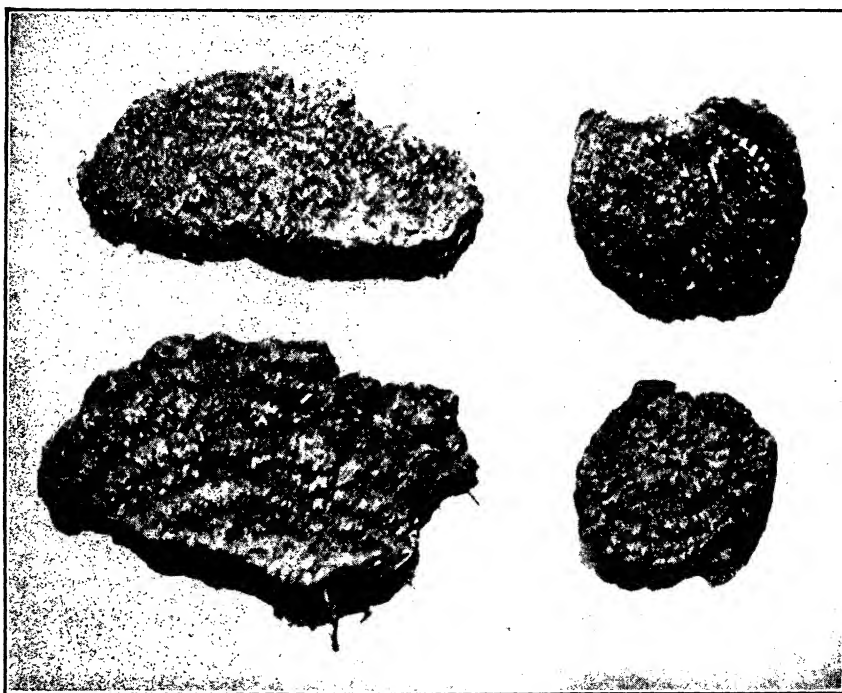


FIG. 354.—*Ipomœa*,  $\times \frac{3}{4}$ .

is milky-white internally. Its aerial portion consists of cylindrical, slightly villous stems bearing large, petiolate, cordate and acuminate leaves and reddish-purple, bell-shaped flowers. The fruit is a capsule.

**Production and Commerce.**—The root is gathered in the vicinity of Orizaba in the Mexican Andes, cut transversely into disks and dried in the sun. It is packed in burlap bags and exported from Mexico City to the United States.

**Description.**—It occurs in more or less circular, transverse, whole or broken slices from 2 to 12 cm. in diameter and from 1 to 5.5 cm. in thickness; externally brown and deeply wrinkled; fracture tough and fibrous; the cut surface light brown and showing concentric rings of fibrovascular bundles from which coarse fibers protrude; odor distinct, somewhat aromatic, upon scraping it; taste slightly sweet becoming acrid.

**Histology.**—Transverse sections of the macerated drug exhibit the following microscopic structures:

1. *Cork* of several rows of thin-walled, brownish, tabular cells.
2. *Cork cambium* of collapsed meristematic cells.
3. *Cortex* of numerous layers of cortical parenchyma and divisible into an outer zone of a few layers of thin-walled, colorless cells and an inner broad zone of thick-walled, more or less tangentially-elongated cells. Some of these cells contain starch, others rosette aggregates or rhombohedral crystals of  $\text{CaO}$ , while still others contain a reddish-brown to yellow resinous latex.
4. *Collateral fibro-vascular bundles* arranged in concentric circles alternating with layers of parenchyma containing latex cells with resinous content. The sieve tissue of the bundles occurs in semi-cylindrical strands outside of the wood wedges.
5. *Medullary-rays* separating the bundles, broad, and composed of cells containing either starch, calcium oxalate or latex. Resin cells numerous and scattered throughout the parenchyma.

**Powdered Drug.**—Pale brown to weak yellowish-orange; odor distinct, somewhat aromatic; taste sweet followed by acidity; numerous single or 2- to 4-compound starch grains, the individual grains with a central cleft hilum and up to  $35\mu$  in diameter; numerous rosette aggregates and fewer rhombohedra of  $\text{CaO}$ , the latter up to  $45\mu$  in length; numerous fragments of yellowish-brown latex cells or their contents; fragments of tracheæ having bordered pores and of strongly-lignified wood fibers with simple pores.

**Constituents.**—From 6 to 22 per cent. of a *glucosidal resin* containing the glucoside and methylpentoside of jalapinolic acid and its methyl ester; also fat,  $\beta$ -methylæsculetin, dihydroxycinnamic acid, phytosterol, starch and calcium oxalate.

**Use.**—Hydragogue cathartic and source of Resina Ipomœæ or *Mexican Scammony Resin*, N.F.

**Average Dose.**—1 Gm. (15 grains).

**Preparations.**—Ipomea Resin, 0.2 Gm. (3 gr.) entering into Compound Colocynth Extract, 0.25 Gm. (4 gr.).

#### HYDROPHYLLACEÆ (WATER LEAF FAMILY)

Annual, herbaceous, rarely perennial woody plants whose stems, branches, leaves and sepals are often viscous and glandular hairy. Leaves alternate, exstipulate, from simple linear to pinnatipartite to pinnate, usually possessing unicellular non-glandular hairs and glandular hairs with multicellular heads. Inflorescence rarely expanded, usually scorpioid cymes. Flowers small to large, funnel-form in *Eriodictyon californicum*; sepals five, green; petals five, regular; corolla varying from small stellate with slightly fused petals to large rotate, campanulate or tubular, in color varying from greenish-white or yellow to rarely white; often pink, purple or blue; stamens five, rarely with alternate staminodes; pistil bicarpellate. Fruit a two-celled capsule dehiscing usually septically.

## ERIODICTYON N.F. (ERIODICTYON)

**Synonyms.**—*Yerba Santa*, Consumptives Weed, Gum Bush, Mountain Balm, Bear's Weed; *Fr.* Feuilles d'Eriodictyon; *Ger.* Eriodictyon.

**Botanical Origin.**—*Eriodictyon californicum* (Hooker et Arnott) Torrey.

**Part Used.**—The dried leaf.

**Purity Rubric.**—Not more than 5 per cent. of its stems or more than 2 per cent. of other foreign organic matter.

**Habitat.**—In hilly and rocky regions of California and Mexico.

**Plant.**—An evergreen shrub with alternate, lanceolate leaves infundibuliform, violet or white colored flowers and capsular fruits.

**Collection.**—Yerba Santa is collected for the market in Lake county and also near Los Angeles, California.

**Description.**—The drug usually occurs as fragments of leaves mixed with stem segments and entire leaves; when entire, leaves lanceolate from 5 to 15 cm. in length and from 1 to 3 cm. in breadth; short petiolate, coriaceous, brittle, with acute apex, tapering base, irregular serrate or crenate-dentate margin, the upper surface yellowish to weak brown or greenish brown, coated with resin, the lower surface yellowish brown to weak greenish yellow, conspicuously pinnate-reticulate; tomentose between the reticulations; odor aromatic; taste balsamic and bitter, later becoming sweetish and slightly acid.

**Histology.**—Transverse sections of the lamina show the following structural peculiarities:

1. *Upper epidermis* of large sized, clear epidermal cells and numerous, deep-seated, glandular hairs with short, 1- to 3-celled stalks and multicellular heads, mostly up to 8-celled. In surface sections the epidermal cells appear polygonal and show striations due to indentations of outer walls.

2. *Palisade parenchyma* consisting of 2 to 6 rows of narrow palisade cells, possessing chloroplastids, through which are interspersed perpendicular rows of parenchyma cells each containing a rosette aggregate crystal of calcium oxalate.

3. *Spongy parenchyma* comprising a narrow zone of loose chlorenchyma through which the fibrovascular tissue courses. Rosette crystals present.

4. *Lower epidermis*, sinuate or undulate, with numerous narrow, curved non-glandular hairs that nearly fill the sinuses, concealing the stomata. Deep-seated glandular hairs also occur in this region.

A variety of this species possesses a few unicellular, non-glandular hairs on its upper epidermis.

Sections of the stem show the following characteristics:

1. *Epidermis* bearing deep-seated glandular hairs, each with a very short stalk wedged in between adjacent epidermal cells, and a glandular head of up to 8 or more cells.

2. *Cork*, the cells of which early become lignified. In older portions of stems cork replaces epidermis.

3. *Primary cortex* of 10 to 20 rows of rounded cortical parenchyma cells.

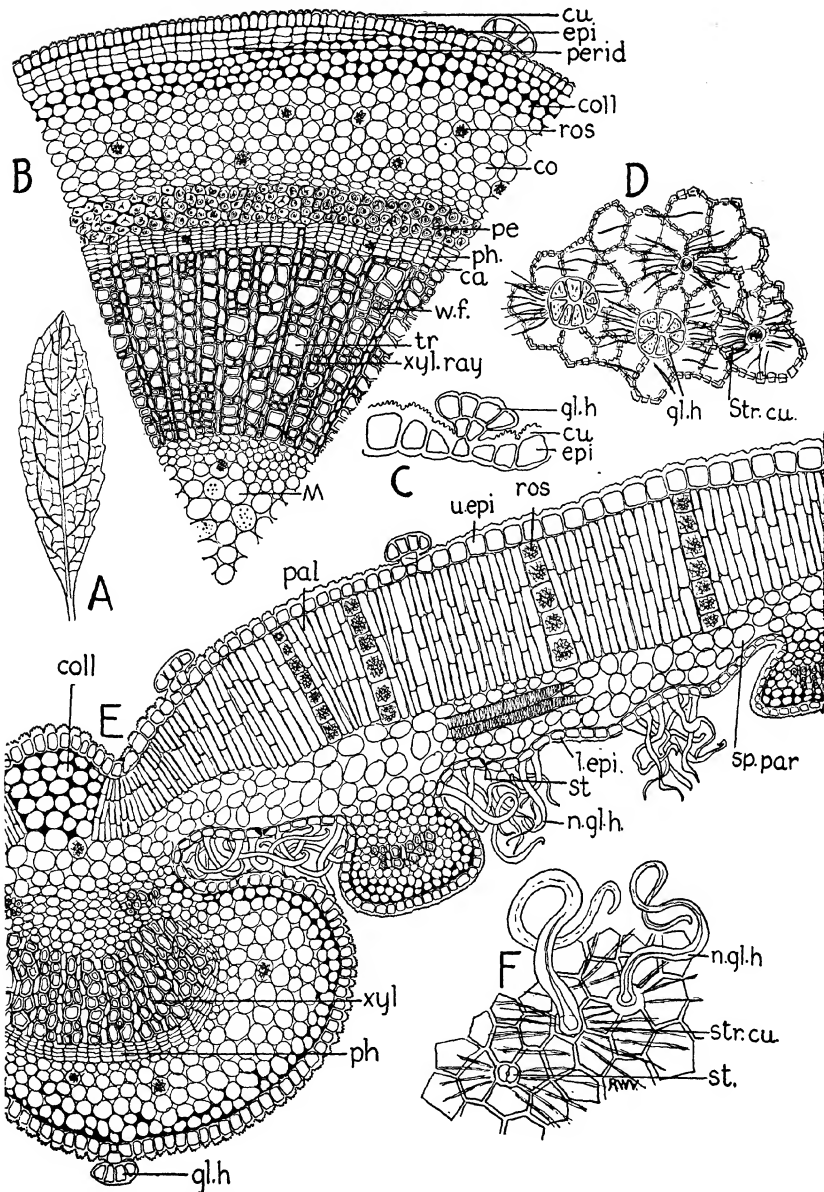


FIG. 355.—*Eridictyon*. A, Leaf. B, Stem in transverse section. C, portion of upper epidermis of leaf in transverse section, enlarged. D, portion of upper epidermis of leaf in surface view. E, Leaf in transverse section, enlarged. F, portion of lower epidermis of leaf in surface view. *cu*, cuticle; *epi*, epidermis; *perid*, periderm; *coll*, collenchyma; *ros*, rosette aggregate of calcium oxalate; *co*, cortex; *pe*, pericycle containing fibers; *ph*, phloem; *ca*, cambium; *wf*, wood fibers; *tr*, trachea and *xyl. ray*, xylem ray of xylem; *M*, medulla; *n.gl.h.*, non-glandular hair; *gl.h.*, glandular hair; *st*, stoma; *u.epi*, upper epidermis; *l.epi*, lower epidermis; *pal*, palisade parenchyma; *sp. par*, spongy parenchyma; *str. cu.*, striated cuticle; *xyl*, xylem and *ph*, phloem of meristele in midrib. (Drawing by R. W. Vander Wyk.)

4. *Pericycle*, in which occurs a nearly closed ring of lignified sclerenchyma fibers.

5. *Phloem*, a narrow zone of sieve tubes and phloem parenchyma, traversed by narrow phloem medullary rays.

6. *Cambium*, of meristematic cells.

7. *Xylem* of numerous wood wedges, separated by medullary rays that are one-cell in width. Each wood wedge consists of numerous strongly lignified wood fibers scattered amongst which are spiral and pitted tracheæ.

8. *Medulla*, a broad central zone of pith parenchyma whose walls are porous and strongly lignified.

**Powdered Drug.**—Greenish yellow. Fragments of upper epidermis with large polygonal cells having straight vertical walls and linear striated cuticle; fragments of lower epidermis with small polygonal epidermal cells and stomata; numerous wavy, narrow, unicellular, non-glandular hairs or fragments thereof; glandular hairs each with a 1- to 3-celled stalk and an up to 8 or more-celled resinous head, the latter up to  $120\mu$  in diameter; fragments of stem tissues; fragments of palisade tissue containing regularly arranged rows of parenchyma cells each containing a rosette aggregate crystal of calcium oxalate; numerous rosette aggregate crystals from 5 to  $30\mu$  in diameter, fragments of spiral and simple pored tracheæ associated with lignified fibers. The non-glandular trichomes, when entire, are up to  $250\mu$  in length.

**Constituents.**—*Resin, volatile oil, eriodictyonon*, tannin, gum, fixed oil, xanthoeriodictyol, sugar, etc.

**Uses.**—Expectorant. Also to mask the taste of bitter substances as quinine.

**Average Dose.**—1 Gm. (15 grains).

**Preparations.**—Eriodictyon Fluidextract N.F., 1 cc.; Aromatic Eriodictyon Syrup N.F., 8 cc.

**Adulterant.**—Leaves of *Eriodictyon tomentosum* which has oval, obtuse and larger leaves of lighter color and shorter villous hairs.

#### BORAGINACEÆ (BORAGE FAMILY)

Mostly rough, hairy, mucilaginous, and slightly bitter herbs (Borage, Hound's Tongue, Blue-weed, Comfrey, etc.), few being shrubby plants (*Heliotrope*), forming a primary root and single or often branched shoots. Leaves alternate, simple, entire, exstipulate, usually hairy, rarely glabrous. Inflorescence a raceme of dichesial or scorpioid cymes, at times condensed into a simple scorpioid cyme with flowers on one side of the branches. Flowers pentamerous passing to slight or marked irregularity as in the Blue-weed (*Echium*), regular; sepals 5, green, slightly or deeply gamosepalous often hairy, petals 5, the corolla varying in shape from rotate with a shallow tube as in Forget-me-not (*Myosotis*) and Borage, to tubular as in Comfrey (*Symphytum*), to salverform as in Stickseed (*Lappula*), to funnel-shaped as in Hound's Tongue (*Cynoglossum*) and most species; frequently purple-blue to blue; stamens 5, epipetalous and inserted on tube of the corolla; pistil bicarpellate, syncarpous, embryologically 2-celled with two ovules in each cavity, but dorsal ingrowths divide the ovary

by time of flowering into four cells with one ovule in each cavity; style single, gynobasic. Fruit typically four one-seeded nutlets. Seeds either scanty albuminous (sub-family *Heliotropææ*) or exalbuminous (sub-family *Boraginææ*).

#### ALKANNA (ALKANET)

**Synonyms.**—Alkanet Root, Alcanna Root, Spanish Bugloss; *Ger.* Alkanna-wurzel; *Fr.* Orcanette.

**Definition.**—The dried root of *Alkanna tinctoria* Tausch.

**Plant.**—A biennial or perennial herb, 1 to 2 ft. in height with pubescent, lanceolate leaves and blue or purple trumpet-shaped flowers arranged in loose one-sided scorpioid racemes.

**Commercial Source.**—Hungary.

**Description.**—When entire, fusiform with a several headed crown; fragments with bases of hairy leaves or branches; usually in pieces of light weight and up to 25 cm. in length and averagely from 5 to 15 mm. in diameter, somewhat twisted; extremely dark reddish-purple or maroon colored, deeply furrowed. The bark and frequently the wood more or less decomposed and separating into papery layers or strips; fracture short; texture loose and spongy; odor indistinct; taste bitter and astringent.

**Constituents.**—Two red coloring substances called alkannic and anchusic acids. Alkannic acid is soluble in ether and alcohol and becomes blue with alkaline solutions; anchusic (anchuric) acid is soluble in benzene becoming green with alkalis. *Alkannin* or *anchurin* represents a deep red oleoresinous mixture obtained by extracting alkanet root with benzene or petroleum ether and evaporating the solution.

**Uses.**—Coloring agent for oils, ointments, etc. and in the form of a tincture in microscopy for the detection of oil or fat which it stains red.

**Adulterants.**—1. Syrian Alkanet, the root of *Macrotomia cephalotes* DC. (Fam. *Boraginaceæ*), a perennial herb indigenous to Syria and Armenia. This differs from Alkanna in being many headed, more twisted, of larger size (20–40 cm. long and 2–5 cm. in diameter), of a black violet color and metallic luster and in having laterally-placed wood. 2. The root of *Onosma echioides* L. (Fam. *Boraginaceæ*), a native of Southern Europe. Both of these are richer in coloring principles than Alkanna.

#### SYMPHYTUM (COMFREY)

**Synonyms.**—Comfrey Root, Common Comfrey, Blackwort; *Ger.* Beinwurz, Schwarzwurz; *Fr.* Consoude.

**Definition.**—The dried rhizome and root of *Symphytum officinale* L.

**Plant.**—A perennial herb up to 3 ft. in height with a thick fusiform root, branched, white hairy stems, the leaves decurrent, ovate-lanceolate below to oblong-lanceolate above, the flowers white, scarlet, reddish-purple to blue in varieties and in pendulous cymes.

**Habitat.**—Europe. Naturalized in the U.S.



**Description.**—Entire rhizome and root fusiform, branched; 3 dm. in length and up to about 2–5 cm. thick, usually in transverse, oblique or longitudinal pieces; externally brownish-black, deeply wrinkled; internally somewhat horny, grayish; fracture short, exhibiting a thick bark and broad wood. The latter



FIG. 356.—*Borago officinalis* Linné.  $\times \frac{1}{2}$ .

distinctly radiate with broad medullary rays and short, narrow wood bundles; odor indistinct; taste sweetish, mucilaginous and very slightly astringent.

**Constituents.**—*Mucilage*, an oxidation product of uric acid called *allantoin* ( $C_4H_6N_4O_3$ ); two poisonous alkaloids, viz., *consolidine* and *symphytocynoglossine*; a little tannin, starch, sugar, asparagin. Both alkaloids are depressants to the central nervous system.

**Uses.**—Comfrey is used in domestic medicine as a demulcent in chronic catarrhs and certain mucous membrane affections of the pulmonary and gastrointestinal tracts. Allantoin in 0.3 per cent. aqueous solution has been used in the treatment of external ulcers as well as ulcers of the stomach and duodenum.

**Dose.**—8 to 15 Gm. (2 to 4 drachms). Dose of allantoin,  $\frac{1}{2}$  to 2 grains.

#### BORAGO (BORAGE)

**Synonyms.**—Common Borage; *Ger.* Boretsch; *Fr.* Bourrache.

**Definition.**—The dried leaves of *Borago officinalis* L.

**Habitat.**—Europe and northern Africa.

**Plant.**—A bristly hairy annual herb up to 2 ft. in height with ovate, elliptic to oblong leaves and blue flowers. Unicellular cystolith hairs occur on leaves and stems.

**Constituents.**—*Mucilage*, *potassium nitrate*, calcium oxalate, etc.

**Uses.**—Chiefly in the form of an infusion or fluid extract as a demulcent, refrigerant and diaphoretic.

**Dose.**—4 Gm. (1 drachm).

**Allied Drugs.**—*Pulmonaria* or Lungwort is the dried leaves of *Pulmonaria officinalis* L., a perennial European herb. Demulcent expectorant. 2 to 4 Gm. *Cynoglossum* or Hound's Tongue is the dried herb of *Cynoglossum officinalis* L., a strong scented biennial with lanceolate leaves and a panicle of reddish-purple funnel-shaped flowers, native to Europe but naturalized in the U.S. It contains the poisonous alkaloid, *cynoglossine*, the poisonous glycoside, *consolidin*; *mucilage*, choline, etc. Demulcent and sedative.

#### VERBENACEÆ (VERVAIN FAMILY)

Herbs (*Verbena*, *Lippia*), shrubs (*Clerodendron*), rarely trees (some *Premna* spp., *Tectona grandis* or Teak-wood) whose stems and branches are usually quadrangular and rarely scented. Leaves generally opposite, exstipulate, simple or compound. Inflorescence a terminal panicle of spikes (*Verbena hastata*), a cyme (*Callicarpa*) or head (*Lippia lanceolata*). Flowers white, pink or blue (*Verbena hastata*) irregular, more or less 2-lipped; calyx gamosepalous, tubular; corolla gamopetalous, hypogynous, tubular, with a 4- to 5-fid limb; stamens generally 4, didynamous and inserted on the corolla tube or throat; pistil of 2 to 4 carpels, with a superior ovary, a terminal style and undivided stigma. Fruit a drupe or 2- to 4-celled berry, usually splitting into as many nutlets. Seeds exalbuminous.

#### VERBENA (VERBENA)

**Synonyms.**—Blue Vervain, Wild Hyssop; *Ger.* Eisenkraut; *Fr.* Verveine.

**Botanical Origin.**—*Verbena hastata* Linné.

**Part Used.**—The dried aerial portion.

**Habitat.**—In moist fields and meadows of eastern and central United States.

**Plant.**—A rough puberulent herb with erect, quadrangular, puberulent stem, branched above. Leaves opposite, petioled, lanceolate or oblong-lanceolate, acute or acuminate at apex, base tapering, margin serrate, sometimes



FIG. 357.—*Verbena hastata* L., the Blue Vervain. (Right) Stem bearing opposite, lanceolate leaves and a terminal panicle of spikes with blue flowers. (Left) A panicle of spikes.  $\times \frac{1}{2}$ .

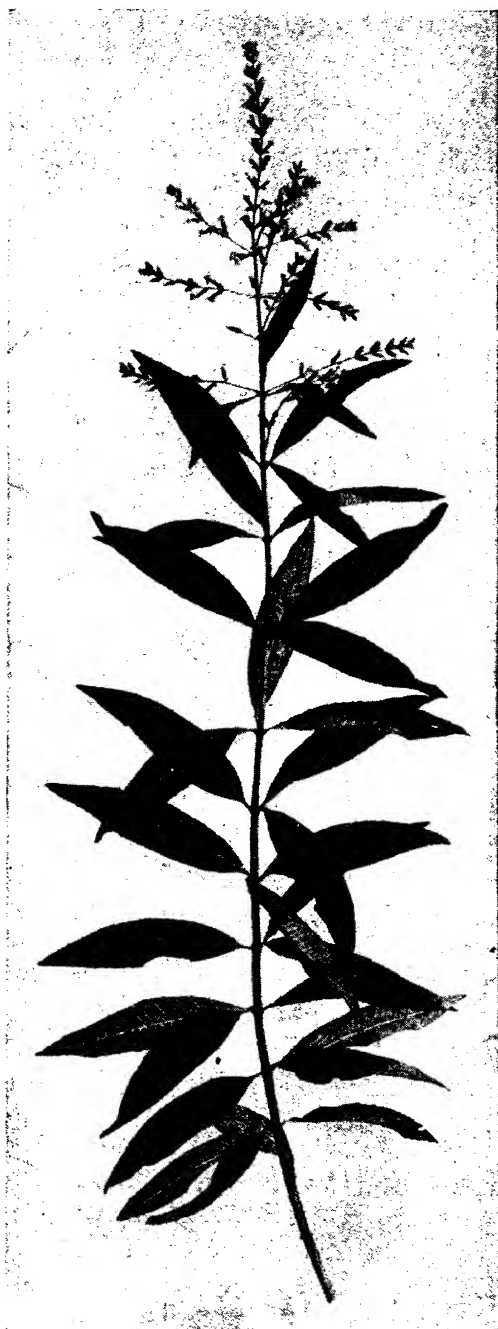


FIG. 358.—*Lippia citriodora* Kunth., the Lemon Verbena,  $\times \frac{1}{2}$ .

pinnatifid, the lower leaves occasionally and hastately 3-lobed at base. Inflorescence a terminal panicle of densely flowered spikes of usually blue (occasionally white or pink) flowers.

**Production and Commerce.**—The plants are cut down during flowering and dried in the sun. The commercial supply is obtained from wild plants.

**Description.**—In broken or cut pieces; stem 4-sided, rough, pubescent; leaves opposite, petioles 12 to 25 mm. long, blades up to 12 cm. in length, lanceolate, acute or acuminate, softly and sharply serrate, or the lower hastately 3-lobed, deep green above, paler beneath, prominently veined; inflorescence a panicle of dense interrupted spikes, each spike being cylindraceous, each flower subtended by a lanceolate acute bract; calyx tubular, 5 lobed; corolla small, blue, white or pink, salverform, hairy externally, 5 lobed; fruit 4 nutlets; odor heavy on moistening; taste bitter and unpleasant.

**Constituents.**—A bitter glucoside called *verbenalin*, tannin, etc.

**Uses.**—Verbena is employed in the form of a hot infusion as a diaphoretic, tonic and expectorant.

**Average Dose.**—1 Gm. (15 grains).

**Allied Product.**—**Lemon Verbena.** The dried leaves of *Lippia citriodora* Kunth (Fam. *Verbenaceæ*), a small shrub with lemon-scented lanceolate leaves and spikes of white flowers, native to Argentina, Chile and Uruguay and cultivated in this country. The leaves are used in cooling drinks and as a source of Verbena oil.

#### LABIATÆ (MINT FAMILY)

Herbs producing creeping runners that spread out and root at the nodes. Stems quadrangular, rarely cylindrical in outline. Leaves opposite, decussate, mainly petiolate; leaf margin nearly always serrate, dentate or crenate. Stems and leaves further characterized by the presence of glandular hairs containing aromatic volatile oil. These hairs consist of a short one-celled stalk and a head (gland) of one to eight cells. Inflorescence a raceme or spike of verticillasters (double dichesial cymes) or, as in the Ground Ivy, a reduced verticillaster. Flowers typically pentamerous, rarely tetramerous; sepals five, synsepalous, ribbed and forming a tubular, regular or irregular bilabiate (Scullycap, etc.) calyx whose upper lip is bifid and lower trifid; corolla of five to four gamopetalous petals, hypogynous, frequently two-lipped, the upper lip bifid, the lower trifid; stamens four, didynamous, rarely one pair alone fertile and the other pair reduced, in some cases almost or quite to disappearing point (*Salvia* and *Monarda*); pistil bicarpellate, embryologically two-celled with two ovules in each cavity, becoming, at time of flowering, four-celled with one ovule in each cavity. Style embryologically terminal, but, upon opening of flower, deeply gynobasic, elongate, slender, with two stigmatic surfaces. Fruit consisting of four nutlets enclosing as many exalbuminous seeds.

#### THYME N.F. (THYMUS)

**Synonyms.**—*Common Thyme*; *Garden Thyme*, *Mother of Thyme*; *Fr. Thym*; *Ger. Thymian*.

**Botanical Origin.**—*Thymus vulgaris* Linné.

**Part Used.**—The dried leaves and flowering tops.

**Standard of Assay.**—Not less than 1.5 cc. of volatile thyme oil from each 100 Gm. of drug.

**Limit of Impurities.**—Not more than 3 per cent. of its stems over 1 mm. in diameter, not more than 2 per cent. of other foreign organic matter; it yields not more than 4 per cent. of acid-insoluble ash.

**Habitat.**—Southern Europe.

**Plant.**—A low aromatic shrub, 20 to 30 cm. in height with ascending, quadrangular, grayish-brown to purplish-brown branches bearing oblong-lanceolate to ovate-lanceolate grayish-green leaves that are pubescent beneath. The flowers are pale purple in color and appear in verticillasters and terminal dense cymes. The fruit consists of 4 ovoid nutlets.

**Production and Commerce.**—Thyme, while native to Spain, France and Italy, has been extensively cultivated in Germany, Greece, and various other countries both for seasoning and for its volatile oil. It is propagated readily from seeds sown in drills in the early spring in rows about 3 ft. apart and from cuttings rooted in sand under glass and later transplanted to mellow upland soil. Cultivation is necessary. The plantings should be renewed about every 3 years. The crude drug is obtained by cutting off the tender stems and flowering tops when in full bloom and carefully drying on trays with fine mesh wire or muslin bottoms in the shade. The entire plants are collected for the production of volatile oil, when they are in full bloom, and distilled by steam without drying. The commercial supplies of the drug have been largely obtained from Syria, Spain, France, and Italy, being shipped in burlap bags and bales. Some drug is also produced in the U. S.

**Description.**—The drug occurs chiefly as leaves mixed with a small amount of segments of the flowering tops, and flowers. Stems mostly 4-angled, dusky purplish-red to dusky yellow-green, simple or opposite-branched, pubescent, of variable length and usually 0.5 to 1 mm. in diameter, the nodes up to 20 mm. apart, occasionally with attached opposite leaves; leaves linear, linear-lanceolate, ovate or oblong, up to 6 mm. in length and from 0.5 to 2 mm. in breadth; lamina apex acute, base obtuse, tapering into a petiole from 0.5 to 2 mm. in length, margin revolute; upper surface light gray or light brownish gray to weak olive green, puberulent, with numerous hairs; lower surface, grayish, pubescent and glandular-punctate; inflorescence of about 12-flowered axillary whorls; flowers polygamous, the calyx tubular-bilabiate, about 4 mm. in length, pubescent, 9 to 12 nerved, upper lip 3-toothed, lower lip with 2 hairy, ascending attenuate divisions, the throat bearded; corolla about twice as long as the calyx, purplish, bilabiate, upper lip emarginate, lower spreading and 3-lobed; stamens 4, didynamous; ovary 4-parted; stigma bifid; nutlets spheroidal, about 0.5 mm. in diameter, finely tuberculate; odor aromatic; taste aromatic and warming.

**Histology.**—**Leaf.**—Transverse and surface sections of the leaf present the following for examination:

1. *Upper epidermis.* Cells tangentially elongated in transverse section with a thick cuticle and few stomata, somewhat polygonal in surface section with



FIG. 359.—*Thymus vulgaris*. 1. Branch with numerous leaf and flower bearing twigs. 2. Leaf. 3. Pistillate flower. 4. Corolla laid open. 5. Calyx and style. 6. Section of calyx showing pistil within. (After Benlley and Trimen.)

beaded vertical walls and striated cuticle, the stoma being at a right angle to the 2 parallel neighboring cells. Numerous unicellular, non-glandular hairs up to  $30\mu$  in length and uniseriate, 2- to 3-celled, non-glandular hairs up to  $60\mu$  in length with papillose wall and apical cell, straight, or pointed, curved or hooked. Numerous glandular hairs of 2 kinds, one with a short stalk embedded in the epidermal layer and a unicellular head, the other with an 8- to 12-celled head and no stalk.

2. *Palisade parenchyma* of two layers of columnar cells containing many chloroplastids; occasionally an interrupted third layer is present.

3. *Spongy parenchyma* of about 6 layers of irregular-shaped chlorenchyma cells and intercellular-air-spaces. Coursing through this region are collateral bundles, each of which is surrounded by a layer of border parenchyma.

4. *Lower epidermis* similar in aspect to the upper epidermis except for the presence of numerous stomata and more numerous non-glandular hairs of the uniseriate type which are mostly appressed.

**Stem.**—Transverse sections of the stem exhibit the following structures:

1. *Epidermis* consisting of a layer of tangentially elongated cells bearing papillose, non-glandular 1- to 3-celled hairs up to  $230\mu$  in length and short glandular hairs with a 1- to 2-celled stalk and a 1- to 2-celled head.

2. *Cortex*, a narrow region of cortical parenchyma.

3. *Pericycle* consisting of parenchyma and interrupted groups of lignified pericyclic fibers.

4. *Open Collateral Fibrovascular Bundles* arranged in a circle and separated by narrow medullary rays with lignified walls. Each bundle possesses a narrow phloem, a cambium and a broad wedge-shaped xylem, the latter composed largely of wood fibers and spiral tracheæ.

5. *Pith*, a central zone of parenchyma.

**Powdered Thyme.**—Dusky greenish-yellow to pale brown. Numerous fragments of leaves showing chlorenchyma, vascular tissues and epidermis, the latter with non-glandular, sharp-pointed, unicellular, non-lignified hairs up to  $30\mu$  in length and uniseriate, 2- to 3-celled hairs with papillose walls up to  $60\mu$  in length and with the apical cell either straight and pointed or curved or hooked also glandular hairs with a short stalk and a unicellular head or an 8- to 12-celled head without a stalk; fragments of leaf epidermis with thick, uneven striated cuticle, polygonal shaped cells with beaded walls and elliptical stomata, the latter up to  $25\mu$  in length with 2-neighbor cells; fragments of stem with epidermis bearing papillose, non-glandular 1- to 3-celled hairs up to  $230\mu$  in length and short glandular hairs with a 1- to 2-celled stalk and a 1- to 2-celled head also fibro-vascular tissue and parenchyma from pith and cortex.

**Constituents.**—Volatile oil, about 2.5 per cent., containing *thymol*, *carvacrol* (a trace), thymene, cymene and *l*-pinene; tannin, etc.

**Uses of Thyme.**—Antispasmodic, carminative, stimulant, and condiment; an ingredient in poultry dressing; in the flavoring of meat and fish dishes and soups.

**Average Dose.**—4 Gm. (60 grains).



**Preparations.**—Thyme Fluidextract, N.F., 4 cc.; Thyme Syrup, N.F. (from Fld. ext.).

**Thymol** U.S.P. is a phenol occurring in large, colorless, transparent crystals or as a white powder having a thyme-odor and a pungent taste. It is also found in the volatile oils of Ajowan fruit (*Trachyspermum Ammi*), *Thymus Zygis*, *Ocimum gratissimum*, and *Monarda punctata* (horsemint). It is used as an anthelmintic (for hook worm) as an antiseptic and deodorant in mouth

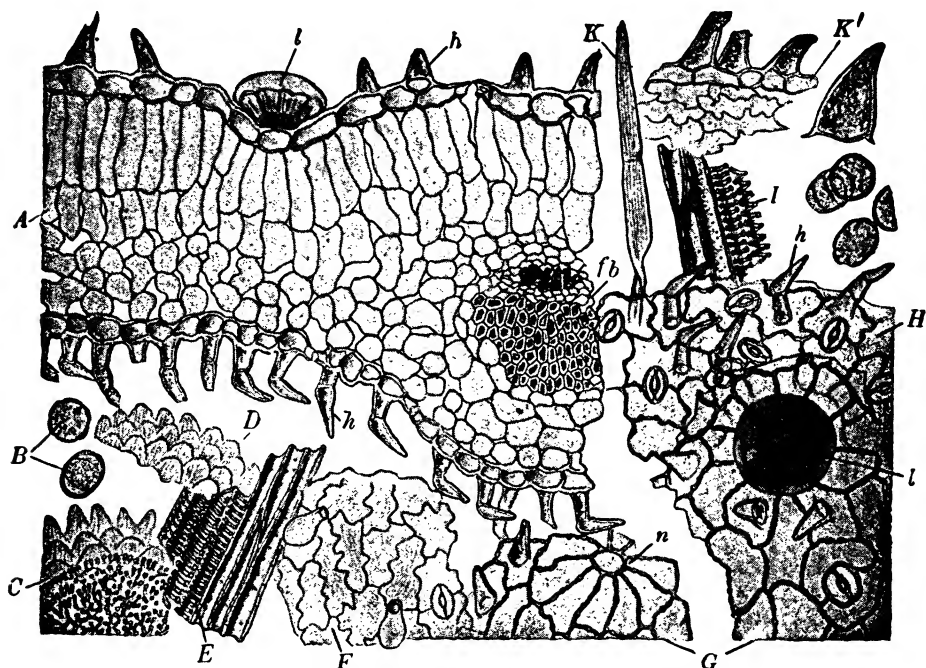


FIG. 360.—Thyme. *A*, Cross section of leaf with a portion of the midrib: *fb*, fibrovascular bundle; *l*, glandular hair; *h*, non-glandular hairs; *B*, pollen grains; *C*, endothecium, on upper border papillose epidermal cells of anther; *D*, papillose epidermal cells of tip; *E*, tracheae and fibers from midrib; *F*, epidermis of calyx-tube in surface view with pear-shaped glands; *G*, upper epidermis of leaf in 2 parts; *H*, lower epidermis in surface view; *h*, non-glandular hairs, *n*, scar of base of hair; *l*, glandular hair; *I*, wood fibers and vessels from stem; *K*, hair from throat of calyx; *K'*, epidermis of calyx-tooth with hairs, to the right a greatly enlarged single hair; otherwise  $\times$  about 300. (After Wasicky.)

washes and gargles and occasionally as an intestinal antiseptic. The average dose, as an anthelmintic, is 2 Gm. (30 grains), divided into 3 doses. **Thymol Iodide** (*Thymolis Iodidum*) N.F. is a mixture of iodine derivatives of thymol principally dithymoldiiodide. Used as a dusting powder in skin diseases.

**Preparations of Thymol.**—Liquor Antisepticus N.F., Liquor Aromaticus Alkalinus N.F., Nebula Aromatica N.F.

**Thyme Oil** (*Oleum Thymi*) N.F. is a volatile oil distilled from the flowering plant of *Thymus vulgaris* L. or *Thymus Zygis* L. and its var. *gracilis* Boiss (Fam. *Labiatae*). It is a colorless, yellow or red liquid with a pungent, persistent taste, a sp. gr. of 0.910 to 0.935 at 25°C., slightly laevorotatory not exceeding  $-3^{\circ}$ ;

ref. ind. 1.4950 to 1.5050 at 20°C. It yields not less than 40 per cent., by volume, of phenols. It has been largely imported from Morocco, Spain and France. Stimulant, carminative and antiseptic. Av. dose, 0.1 cc. (1½ minims).

**Preparations of Oil of Thyme.**—N.F. Antiseptic Solution, Solid Soap Liniment, N.F., Compound Ephedrine Spray, N.F.

**Adulterants of Thyme.**—(1) The leaves and flowering tops of *Origanum creticum* or Spanish hops, indigenous to southern Europe. This substitute may be distinguished from Thyme by its yellowish to light-brown stems, palmately 5-veined, ovate leaves, ovoid or cylindrical spikes, papillated nutlets, and oil containing *carvacrol* (C<sub>10</sub>H<sub>14</sub>O).

(2) The leaves and flowering tops of *Origanum Dictamnus* or Cretan Dittany, indigenous to Crete has reddish-brown stems, elliptical, densely hairy leaves and volatile oil containing *pulegone*.

#### THYMUS SERPYLLUM H.P.

**Synonyms.**—Wild Thyme, Creeping Thyme; Mother of Thyme. *Ger.* Quendel, Wilder Thymian.

**Botanical Origin.**—*Thymus Serpyllum* Linné.

**Part Used.**—The leaves and flowering tops.

**Habitat.**—Europe and Northern Asia. Naturalized in eastern North America from Nova Scotia to North Carolina, and growing in fields.

**Plant.**—A low, prostrate, creeping perennial with pubescent branched stem, opposite, short petioled, ovate, entire, obtuse leaves with very short, tooth-like hairs on their margins, and short, terminal spikes of verticillasters of purplish, spotted flowers. A number of varieties of this species are grown in our gardens including the var. *roseus* with pink flowers, the var. *citriodorus* with smaller, narrower leaves and a lemon odor, and the var. *albus* with white flowers.

**Description.**—Stems quadrangular, about 1 mm. in diameter, dusky red-purple, brown to dusky greenish yellow in color, pubescent, nodes up to 35 mm. apart, occasionally with opposite leaves attached. Leaves obovate, elliptical or ovate, up to 15 mm. in length and from 1 to 5 mm. in width; summit obtuse; base attenuate, tapering into a short petiole; margin revolute, ciliate; upper surface weak olive green, pellucid-punctate, lower surface light green, pellucid-punctate, with few non-glandular and glandular hairs. Inflorescence in 12-flowered verticillasters crowded into short, terminal spikes; flowers polygamous; calyx tubular-bilabiate, glandular hairy with a tuft of white hairs in the throat, upper lip 3-lobed, lower lip of 2 slender attenuate lobes bearing bristly marginal hairs; corolla tubular, bilabiate, purple, or pink, red or white in varieties, as long or longer than the calyx; stamens slightly didynamous and exserted; stigma bifid; nutlets ovoid or oblong, smooth; odor and taste characteristically aromatic.

**Histology.**—**Leaf**: upper epidermal cells with thick striated cuticle and wavy vertical walls and few elliptical stomata; hairs of several types; unicellular, non-glandular, papilla-like hairs up to 30μ in length, occasional uniseriate, non-lignified, non-glandular hairs up to 6-celled but mostly 2- to 3-celled and up to

60 $\mu$  long, deep seated glandular hairs with a 2-celled stalk and an up to 8-celled head; stomata few; a palisade layer consisting of two layers of columnar cells, becoming three layers in some places; a spongy parenchyma region made up of about eight rows of irregular-shaped chlorenchyma cells and numerous fibro-



FIG. 361.—*Thymus Serpyllum* (Wild Thyme).

vascular bundles; lower epidermis similar to upper except that stomata are more numerous. **Stem:** epidermis with cells having convex outer walls with a papillated cuticle, non-glandular hairs of two types, 2- to 3-celled, papillated hairs up to 250 $\mu$  in length and 2- to 5-celled non-papillated hairs up to 500 $\mu$  in length; glandular hairs few, having a 1-celled stalk and a 1- to 2-celled head; a zone of collenchyma beneath the epidermis, well developed in the angles of the stem; a

narrow zone of cortical parenchyma, the innermost layer of which is largest and tangentially elongated; a narrow phloem, and a broad xylem of numerous wood wedges separated by medullary rays 1-cell in width; central pith large, disintegrated.

**Powdered *Thymus Serpyllum*.**—Pale brown to dusky yellow green; short unicellular, non-glandular papilla- or tooth-like-hairs up to  $30\mu$  in length; 2- to 3-celled, non-lignified, non-glandular hairs up to  $60\mu$  long, and 2- to 5-celled non-papillated, non-glandular hairs up to  $500\mu$  in length; 2- to 3-celled papillated, non-glandular hairs from the stem, frequently bent, and up to  $250\mu$  in length; a few hairs from margins of leaves near the flower whorls, that are non-glandular, up to 9-celled and up to 1.3 mm. in length; glandular hairs with a 2-celled stalk and an up to 8-celled head; fragments of leaf tissue composed of chlorenchyma, vascular tissue, and epidermis with broadly elliptical stomata, the latter up to  $25\mu$  in length, numerous fibers with thick lignified walls, and pollen grains about  $20\mu$  in diameter.

**Commercial.**—Most of commercial supplies of the drug have been obtained from Central Europe, but smaller amounts have been gathered in Maine.

**Constituents.**—From 0.15 to 0.6 per cent. of volatile oil containing *carvacrol* and *cymene*; bitter principle, tannin, etc.

**Use.**—Wild thyme is employed as an antispasmodic in the treatment of whooping-cough, dry nervous asthma, severe spasms with little sputum and other respiratory inflammations, either in the form of a fluidextract, tincture or syrup.

**Average Dose.**—2 Gm. (30 grains).

**Preparation.**—Tinctura Thymi Serpylli (10 per cent.), 5 to 30 minims.

#### CATARIA N.F. (CATARIA)

**Synonyms.**—*Catnip*, *Catnep*, *Catmint*, Cat's Wort; *Ger.* Katzenminze; *Fr.* Herbe aux chats.

**Botanical Origin.**—*Nepeta Cataria* Linné.

**Part Used.**—The dried leaves and flowering tops.

**Purity Rubric.**—Not more than 5 per cent. of its stems over 4 mm. in diameter or other foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—Europe. Naturalized in the United States.

**Plant.**—A common perennial herb, widely distributed near dwellings and extensively grown as a garden plant. It arises to the height of 0.8 m., has quadrangular, branched, downy stems, opposite cordate foliage leaves with deeply crenate margins, and dense, interrupted, axillary and terminal spikes or racemes of flowers that are whitish, dotted with purple.

**Production and Commerce.**—The plants are propagated either from seeds or by division of their roots. After they have reached a height of about 5 inches they should be thinned to stand 1 to  $1\frac{1}{2}$  feet apart. Plants that are grown from seed planted in the fall and properly cultivated produce a vigorous growth of herb. The leaves and flowering tops are gathered in late summer, when the



FIG. 362.—*Nepeta Cataria*. 1. Upper part of a flowering stem. 2. Flower. 3. Calyx. 4. Corolla laid open. 5. Anthers. 6. Pistil. 7. Section through gynophore. (After Beniley and Trimen.)

plants are in full bloom, and carefully dried in the shade. The larger stems are removed and the drug placed in bales of 100 to 300 pounds each for the market. Under good conditions, about 2000 pounds of drug per acre have been obtained. Most of the drug is grown in the United States.

**Description.**—The drug usually occurs as broken or crushed tops; when whole, tops up to 20 cm. in length, branched; stems quadrangular, channeled, downy, up to 4 mm. in diameter; foliage leaves petiolate, 2 to 7 cm. in length, 1 to 5.5 cm. in width, outline of blade cordate, ovate or oblong, base cordate or rounded, apex acute, margin deeply crenate, pale grayish-green, soft hairy above, downy beneath; bracts ovate to triangular ovate; flowers small, in dense interrupted spikes of verticillasters; calyx tubular, sub-equally 5-toothed; corolla whitish, dotted with purple, throat dilated, limb bilabiate, the upper lip erect, 2-cleft, the lower spreading, 3-cleft, the middle lobe largest, crenulate; stamens 4, didynamous, the lower pair shorter; odor aromatic and mint-like; taste aromatic, pungent and bitter.

**Constituents.**—*Volatile oil*, bitter principle, tannin, gum, sugar, etc.

**Uses.**—Carminative and stimulant.

**Average Dose.**—4 Gm. (60 grains).

**Preparation.**—Catnip and Fennel Elixir, 0.5 cc. (8 minims) (for infants).

#### MAJORANA (MAJORAM)

**Synonyms.**—Sweet Marjoram, Leaf Marjoram, Sweet Majoram, Garden Marjoram; *Fr.* Marjolaine; *Ger.* Wurstkraut, Meiran.

**Botanical Origin.**—*Majorana hortensis* (L.) Moench (*Origanum Majorana* Linné).

**Parts Used.**—The dried leaves, with or without a small proportion of the flowering tops.

**Purity Rubric.**—Not more than 16 per cent. total ash nor more than 4.5 per cent. acid-insoluble ash, nor more than 10 per cent. of stems and harmless foreign organic matter (S.R.A., F.D., U.S. Dep. Agr., No. 2, Rev. 5, Nov., 1936).

**Habitat.**—Southern Europe, Northern Africa and Asia.

**Plant.**—A perennial herb whose underground portion consists of a fibrous root system. From this arises the aerial, much branched, purplish-brown stem attaining a height of about 30 cm. The branches are woody, thin hairy, quadrangular; and bear opposite, spatulate and short ovate, entire, grayish-green or grayish, glandular-punctate leaves, the younger of which are whitish-tomentose. The inflorescences consist of nearly globular spikes of small reddish-white bilabiate flowers with 2-lipped calyx and 4 rows of thin, rounded, pale green bracts.

**Production and Commerce.**—Sweet marjoram is widely cultivated in Europe and the United States as a seasoning herb. It prefers a warm climate but may be grown in cooler regions of the northern states. It is propagated from seed planted in seed boxes in the greenhouse, the seedlings being transplanted to the field after frosts have disappeared or from cuttings. The aerial

parts of the plants are cut at the ground when in flower and placed on trays in a drying-house with a good circulation of air. When dry, the leaves are stripped from the woody stems with some of the flowers and marketed. Most of the drug, however, has been imported in large bales from France, Tunis, Algeria, Mexico and Chile.



FIG. 363.—Sweet Marjoram (*Majorana hortensis*).

**Description.**—Leaves ovate, oblong, obovate or spatulate, short petiolate, averagely 4 cm. in length; apex obtuse, margin entire, upper and lower surfaces gray green and covered with glandular and non-glandular hairs; texture soft; veins forming loops; bracts green, similar in outline to foliage leaves and small as well as densely pubescent; odor aromatic, characteristic; taste aromatic and slightly pungent.

**Histology.**—Passing from upper to lower surface the following microscopic structures are evident, when viewed in surface and cross sections.

1. *Upper epidermis* with thin cuticle, and epidermal cells having slightly wavy and knotty vertical walls. In surface view scars of the bases of hairs are evident, encircled by cells.

DISTINCTION BETWEEN SWEET MARJORAM AND CORIARIA MYRTIFOLIA

	Sweet marjoram	Coriaria
Leaf	Soft hairy.	Thick, coriaceous with brittle fracture, no pubescence.
Venation	Veins forming indistinct loops.	3-nerved, the smaller veins indistinct.
Odor	Agreeably aromatic.	Indistinct.
Color	Grayish-green on both surfaces.	Green, paler green on lower surface.
Epidermis	Thin cuticle.	Thick cuticle.
Palisade	2 layers.	2 to 3 layers.
Upper epidermis	Cells with slightly wavy, knotty vertical walls. Non-glandular hairs, uniseriate, 2-5 cells in length, more or less bent inward at apex, some papillose. Glandular hairs of 2 kinds, one with a 1- to 2-celled stalk and 1- to 2-celled glandular head, the other with no stalk and a large 8-celled head, the latter sunk in depressions of the epidermis.	Cells with rectilinear vertical walls and a wrinkled cuticle. Hairs absent.
Lower epidermis	Cells with sinuous, knotty, vertical walls; stomata with 2 neighboring cells.	Cells with rectilinear vertical walls; stomata with 2 neighboring cells, more distinctly wrinkled than other epidermal cells.

2. *Mesophyll*, showing differentiation into an upper palisade region of 2 layers of columnar cells (occupying  $\frac{2}{3}$  of the entire mesophyll area) and a lower spongy parenchyma containing numerous air spaces. Through this region course the vascular bundles.

3. *Lower epidermis* with thin cuticle and epidermal cells exhibiting deeply sinuous, knotty-walled cells. Scattered through this region are numerous small stomata, the guard cells of which are surrounded by two neighboring cells.

Both glandular and non-glandular hairs occur on both epidermises. The glandular hairs are of two kinds, viz.: one with a 1- to 2-celled stalk and a 1- to 2-celled glandular head, a second with no stalk and an 8-celled, glandular, cup-shaped head sunken in a depression of the epidermis, the head portion exhibiting an up-raised cuticle. The non-glandular hairs are uniseriate, 2 to 5 cells in length, often finely warty and curved at the apex.



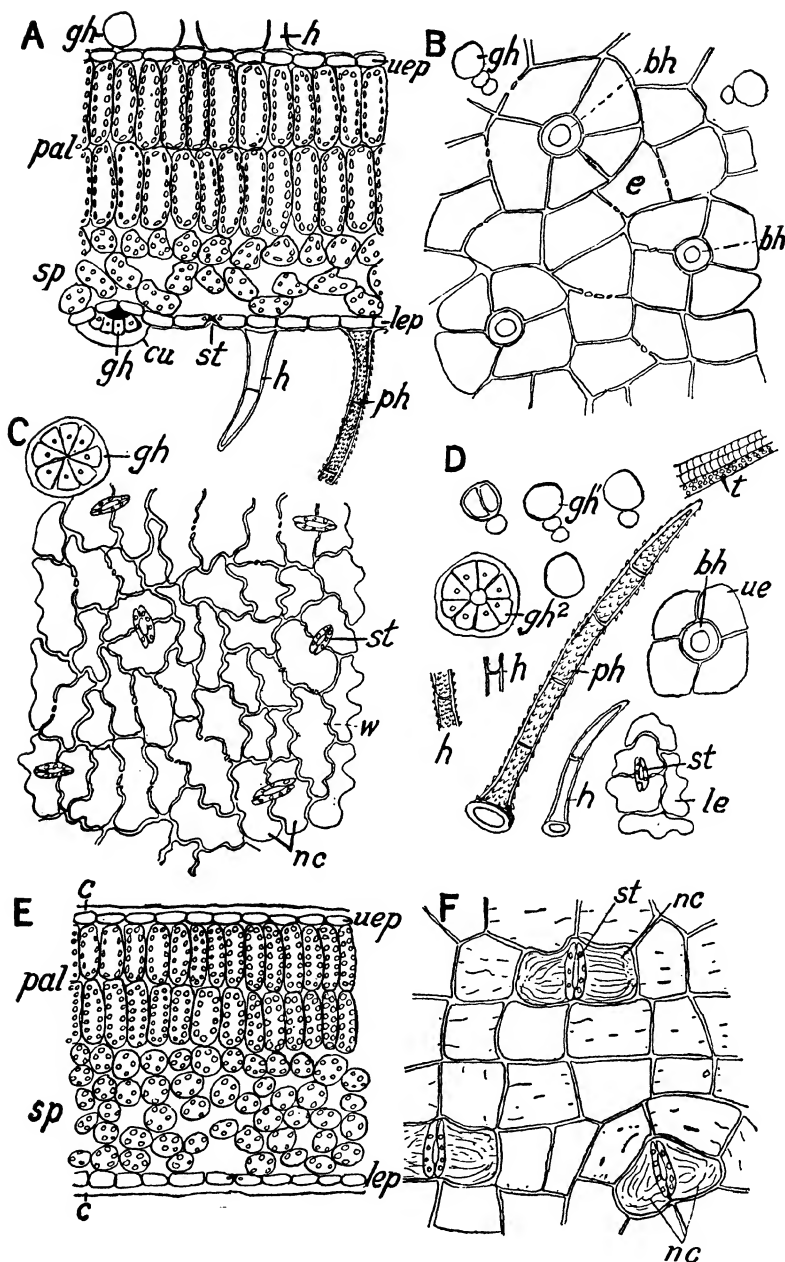


FIG. 364.—Sweet Marjoram (A, B, C and D) and Coriaria (E and F). A, Transverse section of sweet marjoram (*Majorana hortensis*) leaf, showing upper epidermis (uep); lower epidermis (lep); stoma (st); spongy parenchyma (sp); palisade parenchyma (pal); non-glandular hairs (gh); bases of non-glandular hairs (bh) characteristically surrounded by cells of epidermis. B, Vertical view of upper epidermis of leaf. Epidermal cell with porous vertical walls (e); glandular hair (gh); bases of non-glandular hairs (bh) characteristically surrounded by cells of epidermis. C, Vertical view of lower epidermis of leaf. Wavy-walled (Legend continued on p. 719.)

**Constituents.**—*Volatile oil* (1 to 2 per cent.) containing terpenes, *carvacrol*, *terpineol-4*, *camphor* and *borneol*; pentosans, tannin, etc.

**Use.**—Sweet Marjoram is chiefly used as a poultry-seasoner, as seasoning for a number of meats and sausages, in the flavoring of soups, stews, chowders, salads, etc. It has also been employed medicinally as a stimulant, carminative and emmenagogue.

**Average Dose.**—4 Gm. (60 grains).

**Adulterants.**—(1) The leaves of *Coriaria myrtifolia* or Tanner's Sumac (Fam. *Coriariaceæ*) which are frequently cut into narrow segments before being intentionally added to cheapen the article. This adulterant is dangerous on account of its poisonous constituent, *coriariamyrtilin*, which acts similar to picrotoxin found in fish berries. (2) The cut leaves of *Cistus albidus* and *C. salvifolius* (Fam. *Cistaceæ*). (3) Leaves of *Althæa officinalis*, *Rubus idæus*, *Ailanthus glandulosa*, *Cornus sanguinea*, etc. (4) The powdered drug has been adulterated with Thyme and Wild Thyme.

**Allied Drug.**—*Origanum* commonly known as pot marjoram and wild marjoram, consists of the dried leaves and flowering tops of *Origanum vulgare* L., a perennial herb indigenous to Europe and Asia where it thrives best on calcareous dry soil. The dried herb is used as a condiment in the flavoring of salads, etc. It may be distinguished from sweet marjoram by its purplish bracts and more broadly ovate leaves. It possesses a volatile oil containing *carvacrol*, free alcohols and ester (Fig. 365).

Oil of *Origanum* is distilled in the southern provinces of Spain and through the Riff mountains of Morocco. These oils contain from 45 to 65 per cent. of phenol. The volatile oil from Smyrna is yielded by *O. smyrnaceum* L., is yellow and contains 60 to 85 per cent. of *carvacrol* as well as *l-linalool*. That from Trieste is obtained from *O. hirtum* L., is brownish, of higher specific gravity than the Smyrna oil and contains 25 to 60 per cent. of *carvacrol*. The oils have been employed in veterinary liniments.

The oil of *origanum* used in microscopical technique is derived from *Origanum creticum*. It contains about 40 per cent. of *carvacrol*.

#### ROSEMARY (ROSMARINUS)

**Synonyms.**—Garden Rosemary; *Ger. Rosmarin*; *Fr. Romarin*.

**Botanical Origin.**—*Rosmarinus officinalis* Linné.

**Part Used.**—The dried leaves.

**Habitat.**—Mediterranean regions.

epidermal cells (*w*); neighboring cells (*nc*) perpendicular to guard cells surrounding stomata (*st*); 8-celled head of glandular hair (*gh*). *D.* Characteristic elements of powdered drug. Non-glandular hairs and fragments of same (*h*); glandular hairs (*gh*); vertical view of glandular hair with 8-celled head (*gh<sup>2</sup>*); upper epidermis with base of hair (*ue*); lower epidermis (*le*) with stomatal apparatus (*st*); papillose hair (*ph*); tracheæ (*t*). *E.* Transverse section of *Coriaria myrtifolia* leaf. Upper epidermis (*uep*); lower epidermis (*lep*); cuticle (*c*); palisade parenchyma (*pal*); spongy parenchyma (*sp*). *F.* Surface section of lower epidermis of *Coriaria* leaf. Note that the neighboring cells have a distinctly wrinkled cuticle and are parallel to the guard cells of the stomata. The walls of the epidermal cells are rectilinear to slightly curvilinear. (*Drawing by Miss A. Goldberg.*)

TAXONOMIC CONSIDERATION OF DRUGS



FIG. 365.—*Origanum vulgare* Linné or wild marjoram, a condiment.  $\times \frac{1}{2}$ .



FIG. 366.—*Rosmarinus officinalis*. 1. Branch with leaves and verticillasters of flowers. 2. Calyx. 3. Corolla laid open. 4. Vertical section of calyx with pistil. 5. Section of ovary. (After Bentley and Trimen.)

**Plant.**—A bushy, low, much branched, perennial sub-shrub attaining a height of about 6 ft. and bearing aromatic, evergreen, opposite, sessile, linear leaves and verticillasters of pale blue flowers.

**Commercial.**—The commercial supplies of leaves come from France. Most of the oil comes from Spain, France, Tunis and Morocco.

**Description.**—Leaves linear to linear-lanceolate from 1.5 to 3.5 cm. in length and up to 2.2 cm. in breadth, coriaceous; upper surface dark green, lower surface white-woolly, glandular-punctate and showing a prominent midrib; margin revolute; odor aromatic, characteristic; taste pungently aromatic, camphoraceous and bitter.

**Constituents.**—About 1 per cent. of *volatile oil* containing *borneol*; resin, bitter principle and tannin.

**Uses.**—Stimulant, carminative and diaphoretic; in the flavoring of some vegetable and meat dishes, soups and sauces.

**Average Dose.**—4 Gm. (60 grains).

**Rosemary Oil** (*Oleum Rosmarini*) U.S.P. or Oil of Rosemary is distilled with steam from the fresh flowering tops of *Rosmarinus officinalis*. It yields not less than 1.5 per cent. of esters calculated as bornyl acetate and not less than 8 per cent. of total borneol ( $C_{10}H_{17}OH$ ), free and as esters. It is a colorless or pale yellow liquid having the odor of Rosemary and a warm camphoraceous taste.

**Preparations.**—Camphor and Soap Liniment, U.S.P., Solid Soap Liniment, N.F., Compound Lavender Tincture, U.S.P.

#### LAVENDER (*LAVANDULA*)

**Synonyms.**—Lavender Flowers, Garden Lavender; *Fr.* Lavande; *Ger.* Lavendelblüthen.

**Botanical Origin.**—*Lavandula officinalis* Chaix ex Villars (*Lavandula vera* DC.).

**Part Used.**—The carefully dried flowers.

**Habitat.**—Mediterranean regions.

**Plant.**—A crooked, much branched, low shrub with sessile, opposite, entire, oblanceolate-linear, revolute leaves and terminal spikes of verticillasters. Each whorl has 6 to 10 small, fragrant, bluish to lavender colored, tubular-bi-labiate flowers, each arising in the axil of a rhomboidal bract.

**Production and Commerce.**—Lavender is extensively cultivated in hilly and mountainous districts of England and France both for the crude drug and its volatile oil. Most of the lavender flowers and oil of commerce have been imported from France, Spain, Madagascar, Russia, England, Bulgaria and Switzerland. The English lavender is the most highly esteemed by the trade.

Lavender may be grown from seed, but is best propagated from root- or stem-cuttings. The latter are taken from one-year old wood in the spring. These are planted about 4 in. apart in sandy soil containing lime and in a shady place and during the following fall transplanted to dry, light soil containing lime, the plants being set 2 ft. apart and exposed to the sun. In the northern

states the plants should be protected during winter by heavy mulching. Old plants should be pruned in early spring. Lavender yields the best oil when grown at a moderately high altitude. The flowers are stripped from the tops, after these are first carefully dried in the shade.

**Description.**—Calyx tubular, about 5 mm. long, 5-toothed, bluish-gray and glandular hairy, the upper tooth largest and rounded; corolla deep blue, tubular-bilabiate, about 8 mm. long, hairy and glandular, the upper lip 2-lobed, the lower lip 3-lobed; stamens 4, didynamous, perigynous; odor fragrant and characteristic; taste aromatic, bitter, somewhat camphor-like.

**Constituents.**—Up to 3 per cent. of *volatile oil* containing esters, principally *l-linalyl acetate*, also linalool, geraniol, limonene and a sesquiterpene; resin, tannin, etc.

**Uses.**—Lavender flowers are chiefly used as a perfume.

**Lavender Oil** (*Oleum Lavandulæ*) U.S.P. commonly known as *Lavender Flowers Oil* or Oil of Lavender is a volatile oil distilled with steam from the fresh flowering tops of *Lavandula officinalis* Chaix ex Villars. It is a colorless or yellow liquid with an odor of lavender flowers; soluble in 4 vols. of 70 per cent alcohol; sp. gr. 0.875 to 0.888; opt. rot.,  $-3^{\circ}$  to  $-10^{\circ}$ ; ref. ind. 1.4590–1.4700 at  $20^{\circ}\text{C}$ . It yields not less than 30 per cent. of esters calculated as linalyl acetate ( $\text{C}_{10}\text{H}_{17}\cdot\text{C}_2\text{H}_3\text{O}_2$ ). Stimulant, carminative, and perfume. Average dose, 0.1 cc. (1½ minims).

**Preparations.**—Lavender Spirit, U.S.P., 2 cc.; Compound Lavender Tincture U.S.P., 2 cc.; Soft Soap Liniment, U.S.P., Aromatic Ammonia Spirit, U.S.P., Solid Petroxolin, N.F., Perfumed Spirit, N.F., Lead Oleate Ointment, N.F.

**Allied Products.**—Oil of Spike is a volatile oil yielded by *Lavandula latifolia* Vill. or Broadleaf Lavender, a taller growing species of Lavender native to Europe and cultivated largely in Spain. During 1945, 200,357 pounds of this oil were imported into the United States. It contains about 30 per cent. of *cineol* and up to 40 per cent. of free alcohols. It is used in perfumes and by artists in the preparation of varnishes.

*Lavandin* is the product of hybrids between *Lavandula officinalis* and *L. latifolia*. Its oil is intermediate in character between that of the parent species. It is extensively used in perfumery.

#### PEPPERMINT U.S.P. (MENTHA PIPERITA)

**Synonyms.**—Lamb Mint, American Mint, Brandy Mint, Peppermint Herb; *Ger.* Pfefferminze; *Fr.* Menthe poivrée.

**Botanical Origin.**—*Mentha piperita* Linné.

**Part Used.**—The dried leaf and flowering top.

**Purity Rubric.**—Not more than 2 per cent. of stems over 3 mm. in diameter or other foreign organic matter.

**Habitat.**—In low, wet soil along brooks of Europe. Naturalized in United States.

**Plant.**—A perennial herb common in meadows and along brooks and spreading rapidly by runners. Its stems are erect or ascending, branched and 1 to



FIG. 367 — *Mentha piperita*. 1. A flower. 2. Corolla cut open. 3. Vertical section of calyx and ovary. (After Bentley and Trimen.)

3 ft. in height, the upper portion always quadrangular. Its leaves are opposite, petiolate, ovate-oblong to oblong-lanceolate, serrate, pointed and dark-green on the upper surface. Its purplish flowers occur in thick, terminal, spicoid racemes of verticillasters. Each shows a tubular calyx with 5 sharp, hairy teeth, a purplish, irregular, 4-cleft corolla, 4 short stamens, a 4-celled ovary and a projecting style ending in a bifid stigma. The fruit consists of 4 ellipsoidal nutlets. *Mentha piperita* L. is considered by some geneticists to represent a hybrid between *Mentha aquatica* L., the Water Mint, and *Mentha spicata* L. or Spearmint, but it is possible that it may be a cross between a var. of *M. Niliaca* (*M. spicata* X *M. rotundifolia*) and *M. aquatica*.

**Production and Commerce.**—The drug is harvested in July, August, and September, while the plants are in flower. It is cut and dried like hay. Most of the crude drug is subjected to steam distillation for its volatile oil content. The best Peppermint comes from Michigan, Northern Indiana, Oregon and Washington, where the herb is cultivated on a large scale. Inferior Peppermint comes from North and South Carolina and Virginia where it grows with Spearmint, being collected from wild-growing plants. Much of the drug collected in this section has been found to contain from 30 to 50 per cent. of Spearmint. The largest area of Peppermint production in the world is within a radius of 70 miles of South Bend, Indiana. During 1946, 19,400 acres of peppermint were grown in Indiana, 15,000 acres in Michigan, 8,400 in Oregon and 4,200 in Washington.

Three kinds of peppermint are grown in the United States and Europe: *Mentha piperita*, *M. piperita* var. *officinalis* Sole (var. *officinalis* forma *pallescens* Camus) (**White Mint**) and *M. piperita* var. *vulgaris* Sole (var. *officinalis* forma *rubescens* Camus) (**Black Mint**). White Mint is slender, 1 to 2 ft. in height, with green stems and leaves. Black Mint is rather stout, 2 to 3 ft. in height, with usually purple colored stems and dark green leaves. All of these may be grown in moist soil from stolons or stem cuttings. Stolons are now mostly used for propagation.

Most of the oil of peppermint of commerce is produced near Fenville, Michigan and Mentha, Michigan. Northern Indiana, Washington, Western Oregon, England, France, Italy, Germany, Roumania, and Russia also produce considerable oil. From 1,000,000 to 1,500,000 pounds of peppermint oil are produced annually in the United States.

**Description.**—Leaves more or less crumpled and often separated from the stems; stems quadrangular, from 1 to 3 mm. in diameter, green to dark purple, glabrous except for a few scattered deflexed hairs; leaves when entire ovate-oblong to oblong-lanceolate, opposite, with slightly pubescent petiole from 4 to 15 mm. in length; laminae from 1 to 9 cm. in length and up to 2.5 cm. in breadth, with acute apex, narrowed or rounded base, and sharply serrate margin, light green or purplish-brown, upper surface nearly glabrous, lower surface with a few hairs on the midrib and veins and many amber-colored, glandular hairs; inflorescences of verticillasters usually arranged in compact, oblong or oval terminal spikes, the latter often interrupted at the base and rounded at the



summit, bracts oblong-lanceolate, acuminate at apex, up to 7 mm. in length; calyx tubular-campanulate, green to dark purple, equally 5-toothed, pubescent and glandular; corolla short, tubular-campanulate, light purple, 4-cleft; stamens 4, short and equal; style 2- or 3-cleft at the summit; nutlets ellipsoidal, blackish-brown, about  $500\mu$  in diameter; odor characteristically aromatic; taste aromatic followed by a cooling sensation on drawing in the breath. This sensation is due to the menthol constituent stimulating the cold spots in the mouth.

**Histology.**—Sections made through the lamina outside of the midrib exhibit the following structural characteristics: (See also Fig. 368).

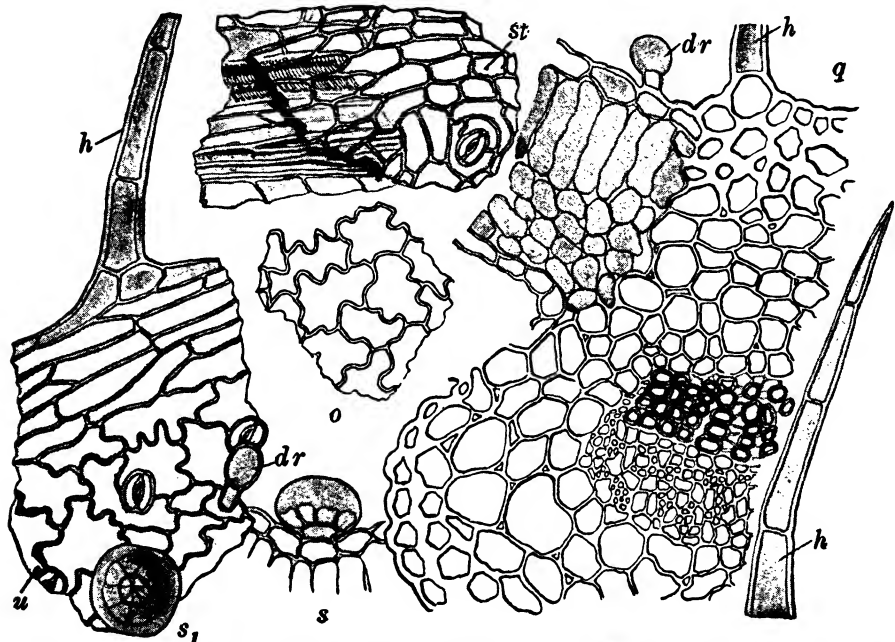


FIG. 368.—Peppermint leaf (*Mentha piperita*). *q*, Cross section with a portion of the midrib; *o*, upper epidermis; *u*, lower epidermis in surface view; *st*, stem in longitudinal section with epidermis, fibers and vessels. In *u*, note in the upper part the elongated epidermal cells above a vein. *S*, disk-shaped glandular hair in cross section; *s'*, the same in surface view; *dr*, small glandular hairs with an unicellular stalk and unicellular head; *h*, uniseriate non-glandular hairs.  $\times$  about 300. (After Wasicky "Leitfaden f.d. Pharmakognostischen Untersuchungen.")

1. *Upper epidermis* composed of large, clear epidermal cells with wavy vertical walls and possessing few or no stomata.
2. *Palisade parenchyma*, comprising a layer of columnar cells rich in chloroplasts.
3. *Spongy parenchyma*, of about 5 layers of irregular shaped chloroplastid-containing cells and intercellular-air-spaces. Through this region the veins course.
4. *Lower epidermis*, of small epidermal cells with wavy vertical walls and numerous elliptical stomata. This epidermis in the region of veins and midrib exhibits as outgrowths non-glandular and glandular hairs. The non-glandular

hairs are uniseriate, papillose, 1- to 8-celled. The glandular hairs have a 1- to 2-celled stalk and a 1- to 8-celled glandular head. These hairs contain the oil of peppermint. In the drug obtained from cultivated plants, the terminal cell of the non-glandular hair often becomes glandular.

**Powdered Drug.**—Green to light olive-green. Fragments of leaf epidermis with thin, wavy, vertical walled cells and, if from the lower epidermis, with numerous stomata and glandular and non-glandular hairs, the latter numerous on the veins; fragments of mesophyll containing chloroplastids; non-glandular hairs, with thin papillose walls and frequently showing short, longitudinal striations, 1- to 8-cells in length, the terminal cell pointed or globular; glandular hairs with a 1- to 2-celled stalk and a 1- to 8-celled, often balloon-shaped head; fragments of collenchyma, parenchyma and epidermis of stem; fragments of flowers, the pollen grains of which are spheroidal and smooth; fragments of vascular tissue, the tracheæ being slightly lignified and with spiral, simple pore or bordered pore markings, the sclerenchyma fibers, thin-walled and non-lignified.

**Constituents.**—About 1 per cent. of a lævorotatory *volatile oil* containing up to 78 per cent. of free *menthol* and up to 20 per cent. of menthol combined as esters; resin, tannin, acetic acid, etc.

**Uses.**—Carminative and flavoring agent.

**Average Dose.**—4 Gm. (60 grains).

**Preparation.**—Peppermint Spirit (*Spiritus Menthæ Piperitæ*), U.S.P.

**Adulterants.**—(1) Spearmint. (2) Leaves of other species of *Mentha*, especially *Mentha arvensis*.

**Peppermint Oil** (*Oleum Menthæ Piperitæ*) U.S.P. is the volatile oil distilled with steam from the fresh, overground parts of the flowering plant of *Mentha piperita* L. (Fam. *Labiata*), rectified by distillation and neither partially or wholly dementholized. It yields not less than 5 per cent. of esters, calculated as menthyl acetate and not less than 50 per cent. of total menthol free and as esters. This volatile oil is colorless, with a strong odor of peppermint and a strong pungent taste followed by a cooling sensation upon drawing air into the mouth. Its constants are: sp. gr. 0.896 to 0.908; opt. rot.,  $-18^{\circ}$  to  $-32^{\circ}$  in a 100 mm. tube at  $25^{\circ}\text{C}$ .; ref. ind. 1.4590 to 1.4650 at  $20^{\circ}\text{C}$ . Stimulant, carminative and flavoring agent. Average dose, 0.1 cc. ( $1\frac{1}{2}$  minims).

**Preparations.**—Peppermint Water, U.S.P., 15 cc.; Peppermint Spirit, U.S.P., 1 cc.; Carminative Mixture, N.F., 0.5 cc.; Soda Mint Tablets.

**Adulterants and Substitutes.**—Oil of Peppermint has been adulterated with dementholized peppermint oil, and substitutes have been offered for it including (1) unrectified peppermint oil containing dimethyl sulfide and (2) Oil of *Mentha arvensis*. The latter may be detected by preparing a 2 per cent. solution of freshly redistilled aniline in glacial acetic acid, adding 5 cc. of this solution to 0.1 cc. of the suspected sample in a test tube, shaking and allowing the contents to stand for 5 minutes. If the oil is from or contains the oil of *Mentha arvensis*, the mixture will turn pink, otherwise the color remains pale yellow.

**Japanese Mint Oil** (Japanese Peppermint Oil) produced extensively in Japan, Brazil and, to a lesser extent, in California, is obtained from *Mentha*



FIG. 369.—Japanese Mint (*Mentha arvensis* L. var. *piperascens* Malinvaud), the chief source of natural menthol.  $\times \frac{1}{2}$ .

*arvensis* L. var. *piperascens* Malinvaud. It has a bitter taste, is less fragrant than American Peppermint oil and contains *menthol*, menthol combined as esters, etc. It represents the only commercial source of natural menthol.

**Menthol U.S.P.** is an alcohol obtainable from oil of peppermint or other mint oils or prepared synthetically. Menthol may be lævorotatory (*l*-Menthol, from natural or synthetic sources) or racemic (racemic Menthol, *dl*-Menthol, produced synthetically). The label on the container shall state whether the Menthol is lævo or racemic. It occurs in colorless hexagonal, usually needle-shaped crystals, or in fused masses, or as a crystalline powder having a strong peppermint-like odor. It is applied externally in solutions for the relief of neuralgic pains, and as an antiseptic and cooling agent in certain skin diseases. Internally it is an antiseptic. Average dose, 60 mg. (1 grain).

**N.F. Preparations.**—Compound Menthol Ointment, Compound Menthol Spray, Aromatic Spray, Compound Ephedrine Spray, Compound Zinc Sulfate Powder.

#### SPEARMINT U.S.P. (MENTHA VIRIDIS)

**Synonyms.**—Mint, Common Garden Mint, Lady's or Mackerel Mint; *Ger.* Grüne Münze, Römische Münze; *Fr.* Menthe vert, Baume vert.

**Botanical Origin.**—*Mentha spicata* Linné (*Mentha viridis* Linné).

**Part Used.**—The dried leaf and flowering top.

**Purity Rubric.**—Not more than 2 per cent. of stems over 3 mm. in diameter, or other foreign organic matter.

**Habitat.**—Europe, in wet places. Naturalized in United States.

**Plant.**—A perennial herb of a lighter shade of green than Peppermint and found in similar localities. Its leaves are opposite, ovate-lanceolate, unequally serrate and nearly sessile. Its purplish flowers are borne in verticillasters arranged upon slender, interrupted, terminal spikes.

**Production and Commerce.**—The leaves and flowering tops are cut down during the late summer while the plant is in full bloom. They are dried similar to Peppermint. The plant is cultivated chiefly in southern Michigan, Indiana and California where in 1946, 8,900 acres were grown for the oil. It is also grown for the crude drug in these states as well as in North and South Carolina, Oregon and New York. Spearmint oil is produced largely in southern Michigan where about 40,000 pounds are produced annually. Because of its prevalence in regions where Peppermint abounds, the drug is often admixed with this herb. Like Peppermint, that coming from the southern states, recently, has contained the more admixture and so has been of rather inferior quality.

**Description.**—Leaves more or less crumpled and mixed with numerous segments of stems; stems quadrangular, often with opposite branches, usually from 1 to 3 mm. in width, ridged, nearly glabrous, green, dusky red or purplish; blade of leaf when entire, ovate-lanceolate 3 to 7 cm. in length, apex acute or acuminate, base narrowed or rounded, margin unequally serrate; upper surface nearly glabrous, lower surface with a few non-glandular hairs on the veins and many amber-colored glandular hairs; nearly sessile or with a petiole less than



FIG. 370.—*Mentha viridis*. 1. A flower. 2. Corolla cut open. 3. Vertical section through calyx and ovary. (After Bentley and Trimen.)

5 mm. in length, bright-green, glandular hairy on lower surface; inflorescence of verticillasters in terminal interrupted or crowded, lanceolate spikes, 3 to 7 mm. in diameter, and in fruit becoming 9 cm. in length; bracts linear-lanceolate, subulate, ciliate, from 7 to 10 mm. in length, subtending the flower clusters; calyx green to purplish-red, campanulate, equally 5-toothed, glandular-hairy and pubescent on teeth; corolla, glabrous, nearly white or from yellowish-brown to weak yellowish-orange, tubular-campanulate, its tube shorter than the calyx, its limb 4 cleft; stamens 4, equal, extending beyond the corolla tube; style 2-cleft at the summit; nutlets ellipsoidal, smooth, about 500 $\mu$  in diameter; odor aromatic, characteristic; taste characteristically aromatic but not followed by a cooling sensation on drawing in the breath.

**Constituents.**—From 0.2 to 0.5 per cent. of *volatile oil* of which about 55 per cent. is *l-carvone*; resin, tannin, etc.

**Uses.**—Carminative and flavoring agent.

**Average Dose.**—4 Gm. (60 grains); of Oil of Spearmint, 0.1 cc. (1½ minims).

**Preparation.**—Spearmint Spirit, U.S.P., 1 cc.

**Adulterants.**—(1) Peppermint. (2) Other species of *Mentha*.

**Oleum Menthæ Viridis** or Oil of Spearmint U.S.P. represents the volatile oil distilled with steam from the fresh, over-ground parts of the flowering plant of *Mentha spicata* L. (Fam. *Labiata*). It is a colorless, yellow or greenish yellow, lævorotatory liquid with a sp. gr. of 0.917 to 0.934 at 25°C. It contains *l*-limonene, *l*-carvone, phellandrene, dihydrocarvol acetate, acetic ester, caproic, caprylic and isovaleric acids and dihydrocuminic acetate, the latter imparting the odor to the drug.

**Preparations.**—Spearmint Spirit, 1 cc.; Spearmint Water, 15 cc.: Soda and Mint Solution (Soda Mint), N.F. (from Spearmint water) 8 cc.

#### MELISSA U.S.P. 1890 (MELISSA)

**Synonyms.**—Common Balm, Balm; *Ger.* Melissenkraut; *Fr.* Mélisse.

**Definition.**—The dried leaves with or without the flowering tops of *Melissa officinalis* L.

**Plant.**—An odorous perennial herb growing throughout Southern Europe, Asia Minor, Caucasus and Southwestern Siberia and Northern Africa and cultivated in gardens. Leaves long petioled, broadly ovate, crenate-dentate, opposite; flowers yellowish to nearly white, in axillary verticillasters.

**Habitat.**—Southern Europe, Asia Minor and Northern Africa.

**Constituents.**—A yellow *volatile oil* containing *citral*, *citronellal*, *geraniol* and *linalool*; tannin, etc.

**Uses.**—Carminative and diaphoretic in the form of a 5 per cent. tea. A source of oil of lemon balm which is used in cosmetics and perfumery. Dose of oil, 1–3 minims as a stimulant and diaphoretic.

#### LEONURUS

**Synonyms.**—Motherwort; *Ger.* Herzgespam; *Fr.* Agripaume, Cardiaire.

**Definition.**—The dried leaves and flowering tops of *Leonurus Cardiaca* L.



FIG. 371.—*Melissa officinalis* L. (Balm, Lemon Balm).  $\times \frac{1}{2}$ .

**Plant.**—A perennial herb with long-petioled leaves, the lower nearly orbicular, palmately 3- to 5-cleft, the upper oblong-lanceolate or rhombic, 3-cleft; purple or white flowers in axillary verticillasters; calyx with prickly teeth.

**Habitat.**—Europe and Asia; naturalized in the United States.

**Constituents.**—*Volatile oil* and *bitter principle*.

**Uses.**—Stimulant, bitter tonic and, by the laity, in the form of a decoction or infusion for amenorrhea.

**Dose.**—2 to 4 Gm. (30 to 60 grains).

### SCUTELLARIA (SCUTELLARIA)

**Synonyms.**—Scullycap, Quaker Bonnet, Madweed, Hoodwort, Mad Dog Skullcap, Helmet Flower; *Ger.* Schildkraut, Helmkraut; *Fr.* Scutellaire.

**Botanical Origin.**—*Scutellaria lateriflora* Linné.

**Part Used.**—The dried overground portion.

**Purity Rubric.**—It contains not more than 3 per cent. of foreign organic matter and yields not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—In wet woods of United States and Canada.

**Plant.**—A perennial, smooth herb with erect, freely branched stem attaining a length of 80 cm. The leaves are opposite, lance-ovate or ovate-oblong, prominently petiolate, the lamina with acute apex, rounded or sub-cordate base and coarsely serrate margin. The inflorescences are axillary and terminal 1-sided racemes of blue, or rarely white or pink, bilabiate flowers. The fruit consists of 4 brown nutlets, enclosed by a persistent calyx having the shape of a Quaker's bonnet. The aerial part of the plant is gathered for medicinal purposes from July to September when in flower and dried.

**Description.**—*Scutellaria* occurs either in the whole, crushed, chopped or pressed condition. When entire, stem quadrangular, 50–80 cm. in length and averagely 1 to 4 mm. thick, varying in color from base upward from purplish-brown to brown to yellowish-green, longitudinally furrowed, with distinct nodes and nearly glabrous, except on inflorescence axes; fracture short. Leaves opposite, from 2 to 7 cm. in length, long petiolate, ovate-lanceolate or ovate-oblong; apex acute or acuminate; base, acute or obtuse; margin coarsely serrate; venation pinnate-reticulate, the veins of the first order anastomosing near the margin; upper surface dark green, nearly glabrous; lower surface pale green with few appressed non-glandular hairs and many glandular hairs. Flowers in axillary and terminal 1-sided racemes; calyx light green, hairy, campanulate-bilabiate and toothed; corolla blue, rarely pink or white, tubular-bilabiate; stamens 4, hairy, the anthers of the 2 lower stamens 1-celled, those of the 2 upper ones 2-celled and cordate; ovary deeply four-lobed; style 2-cleft. Fruit composed of 4 ellipsoidal, tuberculate, brown nutlets about 1 mm. in length, enclosed within a persistent helmet shaped calyx. Subterranean portion consisting of a stoloniferous shoot giving rise to numerous fibrous and branched, slender roots. The odor is slight but characteristic, when powdered; the taste, slightly bitter and somewhat aromatic.

**Powdered Scutellaria.**—Dusky greenish-yellow. The diagnostic elements are the numerous 1- to 3-celled non-glandular hairs with walls having short centrifugal projections, the basal cell large and cylindrical, the apical cell narrowly tapering and often recurved; the nearly spheroidal, smooth pollen grains from 15 to 25 $\mu$  in diameter; narrow scalariform, reticulate and spiral



tracheæ; the wavy-walled epidermal cells and elliptical stomata, the latter about  $20\mu$  in length.

**Constituents.**—A bitter, yellow, crystalline glycoside, known as *scutellarin*; tannin, *volatile oil*, resin, etc.

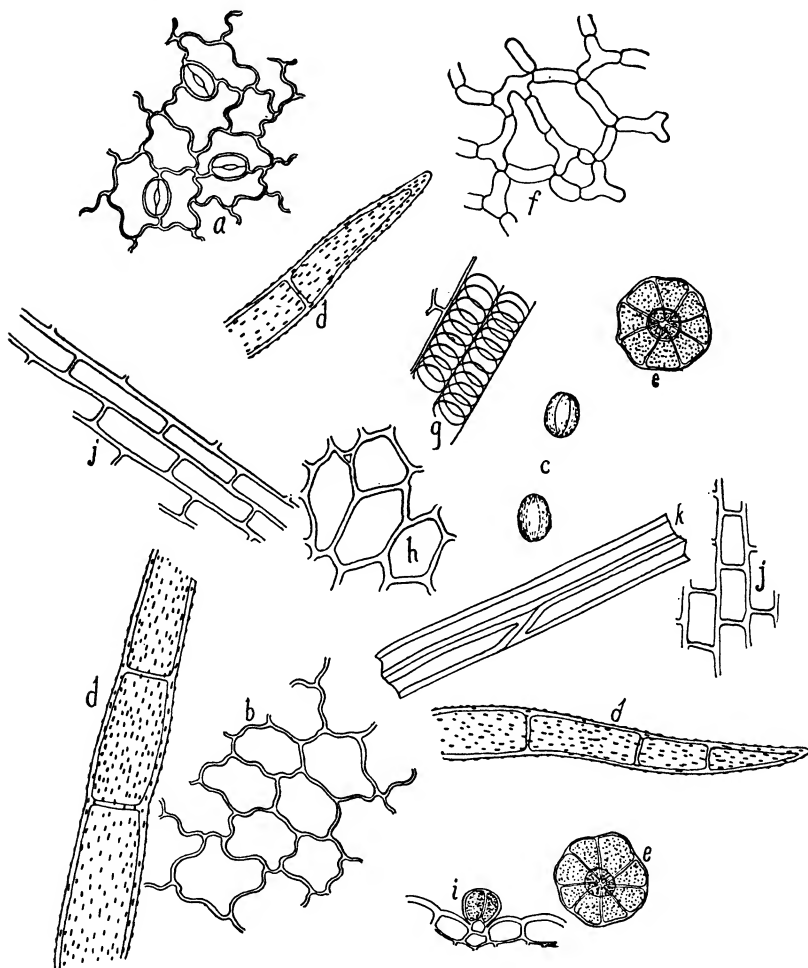


FIG. 372.—A *Scutellaria*. (a) Lower epidermis; (b) upper epidermis; (c) pollen grains; (d) trichomes; (e) glands, top view; (f) spongy tissue of leaves; (g) spiral ducts; (h) parenchyma; (i) small gland and epidermal cells, profile view; (j) parenchyma. (Schneider.)

**Uses.**—Bitter tonic and antispasmodic; an ingredient in Compound Tincture of *Viburnum Opulus*.

**Average Dose.**—1 Gm. (15 grains), in 5 per cent infusion or fluidextract.

**Adulterants.**—(1) The dried overground portion of *Scutellaria cordifolia* Muehl. (*Scutellaria versicolor* Nutt.), commonly known as Heart-Shaped or Southern Scullcap, has been the chief constituent in several samples examined by the writer which were labeled "Southern Scullcap." The plant is found

in the mountainous districts of Virginia, southward and southwestward. It may be distinguished from *S. lateriflora* by its stems showing abundant non-glandular and glandular hairs, by its leaves being cordate at the base (excepting upper ones) and having crenate-dentate margins, and by the non-glandular hairs on its stems and leaves being from 2 to 6 cells in length.



FIG. 373.—Aerial portion (to right) and branch (to left) of *Marrubium vulgare* L.  $\times \frac{1}{2}$ .

(2) The dried overground portion of *Scutellaria canescens* Nutt., commonly known as Western Scullcap, has frequently replaced the official article. This plant grows along streams from Ontario south to Northern Alabama and west to Kansas and Arkansas. It is best distinguished from *S. lateriflora*, by its glandular hairs consisting of a 2- to 6-celled stalk and a large 6- to 8-celled glandular head. Other diagnostic characters are as follows: (a) Non-glandular hairs 3 to 7 cells in length. (b) Larger blue flowers than in *S. lateriflora* and

usually more plentiful. (c) Interfascicular wood pronounced. (d) Leaves and stems abundantly hairy.

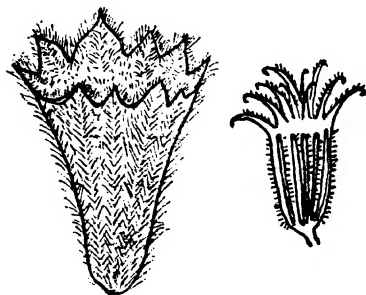


FIG. 374.—Calyx of *Marrubium vulgare* to right; calyx of *Ballota hirsuta* to left.  $\times 4$ .

(3) The dried overground portion of *Scutellaria galericulata* L., the Hooded Willow-herb or Marsh Skullcap. This differs from the official article in having solitary axillary flowers and in possessing averagely smaller leaves of oblong-lanceolate to obovate-oblong outline with averagely smaller teeth.

#### MARRUBIUM

**Synonyms.**—Horehound, Hoarhound, White Hoarhound, Marvel; *Ger.* Adorn, Apfelkraut; *Fr.* Marrube blanc.

**Botanical Origin.**—*Marrubium vulgare* Linné.

**Part Used.**—The dried leaves and flowering tops.

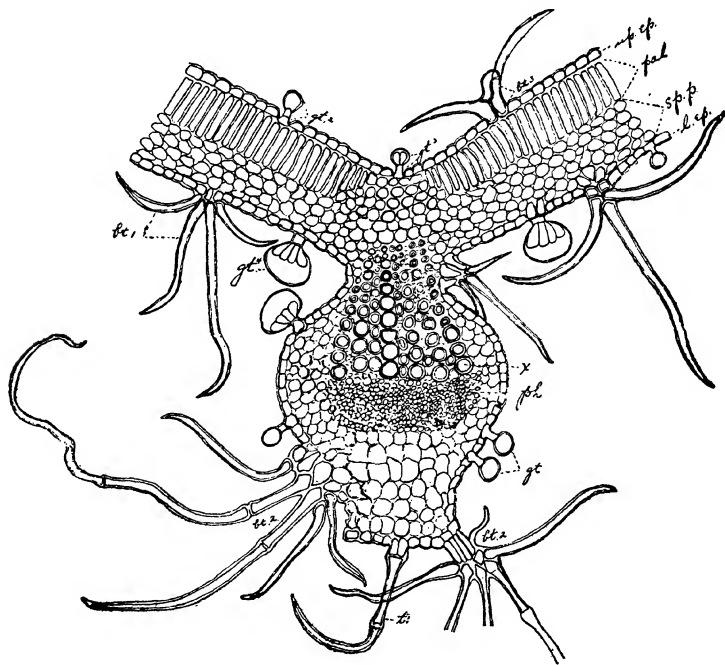


FIG. 375.—Cross section through one of the stronger veins and portion of the lamina of *Marrubium vulgare*. (*up. ep.*) upper epidermis; (*l. ep.*) lower epidermis; (*pal*) palisade parenchyma; (*sp. p.*) spongy parenchyma; (*x*) xylem; (*ph*) phloem; (*l*) long-pointed non-glandular trichome; (*bt<sup>1</sup>*, *bt<sup>2</sup>*) branched trichomes, more or less stalked; (*bt<sup>3</sup>*) sessile branched trichome; (*gt*, *gt<sup>2</sup>*, *gt<sup>3</sup>*, *gt<sup>4</sup>*) several types of glandular trichomes.  $\times 120$ .

**Habitat.**—Europe and Central Asia.

**Plant.**—A perennial herb which is cultivated in various parts of the United States and which grows wild in numerous sections of North America. The

underground portion consists of a short rhizome bearing numerous slender rootlets. The aerial stem is erect, quadrangular, .3 to .8 m. high, 3 to 5 mm. in diameter, branched, the branches ascending. Its white-woolly aspect is very striking. The leaves are opposite, petiolate, exstipulate, varying from ovate to broadly ovate to nearly orbicular in outline, 1.5 to 6 cm. in length, 9 to 25 mm. in breadth; apex obtuse; base narrowed or rounded or sub-cordate; margin coarsely crenate; upper surface downy whitish, lower surface woolly; venation pinnate-reticulate. The inflorescence is a verticillaster with flowers

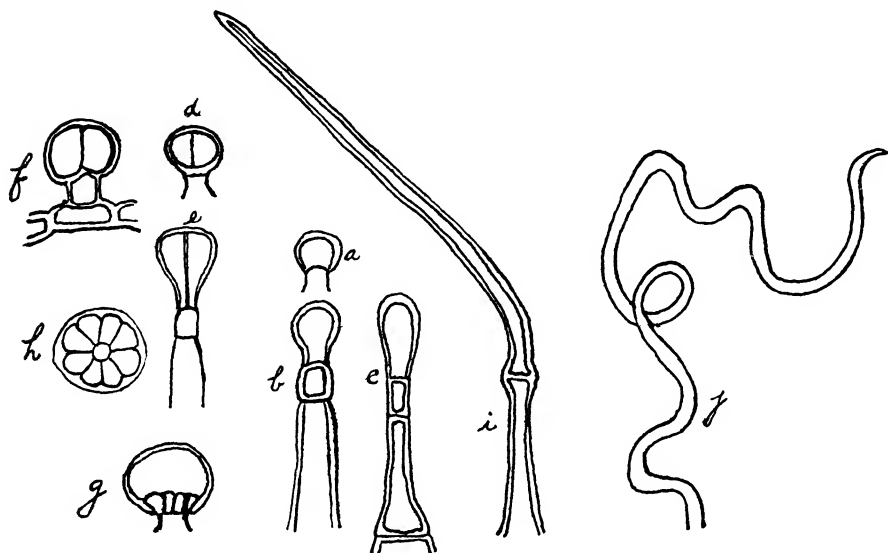


FIG. 376.—Various types of hairs found on *Marrubium vulgare*. (a, b, c, d, e, f, g, h) Glandular hairs, and (i) non-glandular two-celled hair, all found on the foliage leaves and calyxes; (j) curled unicellular-non-glandular hair, a type abundantly found on the stem that gives to this part its white-woolly appearance; (a, d, f) glandular hairs with a one-celled stalk and a one- to two-celled head; (b, c, e) glandular hairs with two-celled uniseriate stalk and 1-2-celled head, the distal cell of the stalk being considerably shortened and forming the "neck cell;" (g) side view, and (h) view from above of large balloon-shaped glandular hair with one-celled stalk and 8-celled head. (All highly magnified.)

arranged in dense axillary whorls, each having a tubular, sparsely pubescent calyx 6 to 7 mm. long, with 10 subulate, recurved, bristle-like teeth, a whitish bilabiate corolla, four parallel stamens ascending under the upper lid of the corolla, and a bi-carpellary pistil with a four-celled ovary. The fruit consists of four nutlets. The odor is aromatic upon crushing; the taste aromatic and bitter.

**Production and Commerce.**—Horehound is cultivated in many parts of the United States and Europe. The leaves and flowering tops are best gathered when the plant is in flower and carefully dried. The bulk of the commercial article is imported from Europe and arrives in tight bales.

**Histology.**—The leaf shows the typical dorsiventral lamina common to the genus *Marrubium*. Transverse and surface sections show an upper epidermis, devoid of stomata, composed of tabular cells with somewhat undulate

outer walls, a layer of vertically elongated palisade cells, several layers of spongy parenchyma cells traversed by collateral bundles, and a lower epidermis similar to that of the upper, but possessing stomata. Non-glandular and glandular trichomes occur as outgrowths on upper and lower epidermis. They are, however, more numerous on the lower epidermis. The non-glandular trichomes are either simple or branched, the latter type predominating. The

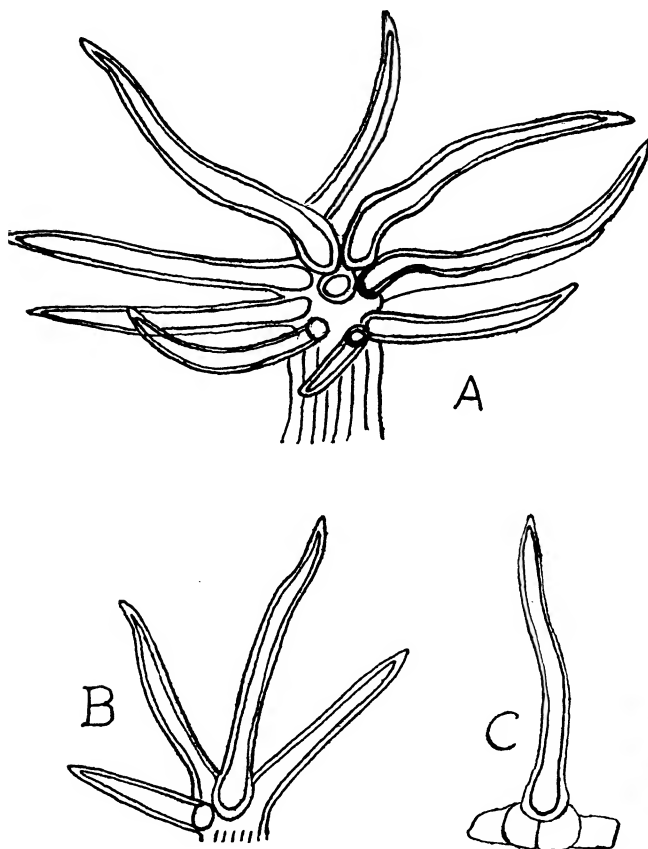


FIG. 377.

FIG. 377.—Non-glandular hairs from calyx of *Marrubium vulgare*. A, Many branched hair with somewhat elongated stalk; (B) branched hair with short stalk and few branches; (C) unicellular, non-glandular hair (highly magnified).

FIG. 378.—*Ballota hirsuta* Benth. Aerial foliage and floral stem. Note the dense axillary clusters of flowers.  $\times \frac{1}{2}$ .



FIG. 378.

simple trichomes are, for most part, unicellular and almost invariably slightly curved. There occur, however, a scattering of much elongated, characteristically curved and twisted (in dried material), unicellular hairs which type predominate on the stem, giving this part its white-woolly aspect (Fig. 376j). In addition to these, uniseriate 2-celled hairs with long pointed and bent distal cell have been met with occasionally.

The characteristic *branched trichomes* are of two kinds, viz.: (1) those that

project directly out of slightly elongated epidermal cells and which are two to three branched and (2) those which consist of a more or less elongated central multicellular stalk with radiating branches (Fig. 375*bt*<sup>2</sup>). As many as fifteen branches have been observed in this type. Of these, those emanating from the base of the stalk are unicellular, and more frequently curved than straight, while

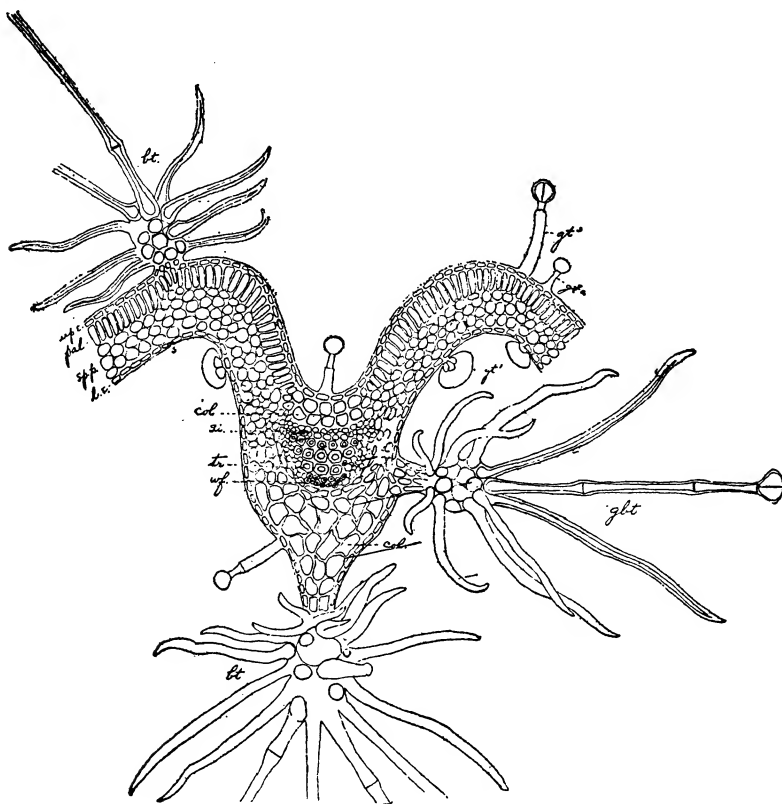


FIG. 379.—Cross-section of foliage leaf of *Ballota hirsuta* made through a stronger nerve and portion of the lamina. (*up. e*) Upper epidermis; (*l. e.*) lower epidermis; (*pal.*) palisade parenchyma; (*sp. p.*) spongy parenchyma; (*s*) stoma; (*col.*) collenchyma; (*si.*) sieve tissue; (*tr.*) trachea; (*wf.*) wood fibers; (*bt.*) branched trichomes; (*glt.*) branched trichome with central branch the longest and bearing a two-celled glandular head; *gt*<sup>1</sup>, *gt*<sup>2</sup>, *gt*<sup>3</sup>, glandular trichomes.  $\times 98$ .

those issuing from points higher up are either unicellular or two or three celled, the distal cell of these last being characteristically long, pointed and curved. The central stalk of the branched trichome does not usually attain the great length of the similar part of the branched trichome of *Ballota hirsuta*.

The glandular trichomes have either a one- to two-celled, short or long stalk and a one-, two- or eight-celled, balloon-shaped glandular head. The large number of the last mentioned (balloon) type which possess unicellular short stalks is very striking (Figs. 375 and 376).

Sections made through the calyx show in modified degree the peculiar

microscopic structure of the foliage leaf. The lamina is thinner and more trichomes of the glandular variety are evident.

**Constituents.**—A bitter principle called *marrubin*, *volatile oil*, tannin, resin, etc.

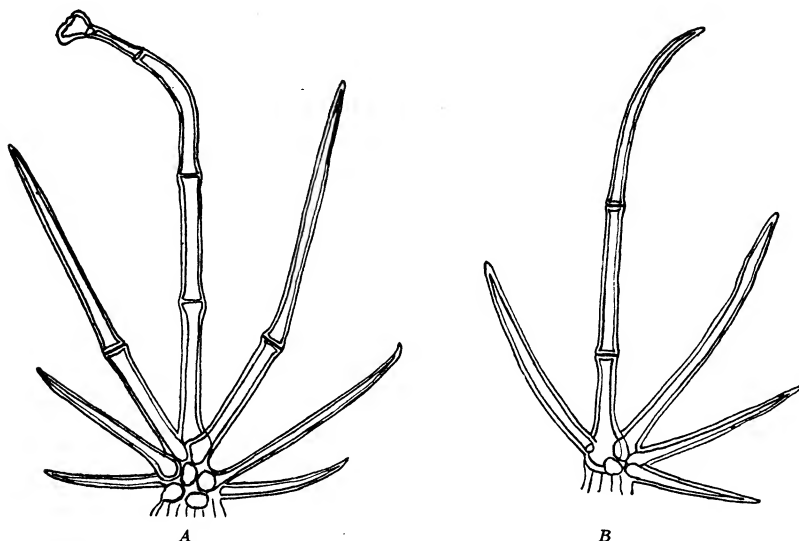


FIG. 380.—Types of branched hairs found on the foliage leaves and calyxes of *Ballota hirsuta*. The illustration to the left shows one of these, the central branch of which is longer than the rest and bears a glandular head at its summit. (Highly magnified.)

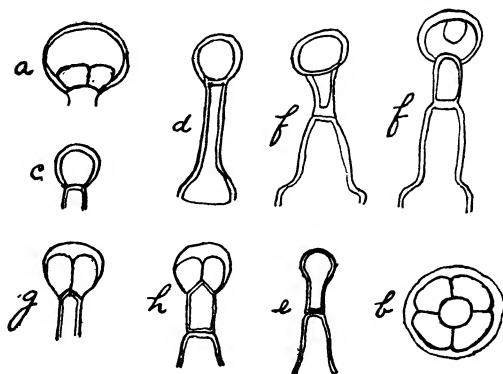


FIG. 381.—Various types of glandular trichomes found on the calyx and foliage leaf of *Ballota hirsuta*. (a) Lateral view, and (b) view from above of the balloon type of glandular trichome showing (in a) the short, unicellular stalk and the lateral aspect of the head, and (in b) a four-celled glandular head; (c, d, e, f, g) other types of glandular trichomes having a 1-2-celled stalk and a 1-2-celled glandular head. (All highly magnified.)

**Uses.**—An infusion is employed in domestic medicine as a bitter tonic and expectorant. Frequently used in lozenges for coughs.

**Average Dose.**—4 Gm. (60 grains).

**Adulterants.**—Horehound has been adulterated with the leaves and flowering tops of *Ballota hirsuta*, *Ballota nigra*, *Marrubium peregrinum* (Black Horehound)

and *M. candidissimum*. The most recent adulterant has been the leaves and flowering tops of *Ballota hirsuta* Benth., a perennial hirsute herb indigenous to Mediterranean countries, (Fig. 378) showing the following macroscopic peculiarities: Stem quadrangular, pubescent but not white-woolly like *Marrubium*. Leaves, opposite, petiolate, ovate to orbicular, coarsely hairy on upper surface, coarsely whitish-woolly on under surface, apex obtuse, base sub-cordate, margin crenate, venation pinnate-reticulate. Inflorescence a verticillaster, the hermaphrodite flowers appearing in dense axillary clusters and usually fewer in number than in the verticillasters of *Marrubium*. Each flower consists of a bilabiate infundibuliform calyx, up to 10 mm. long (Fig. 374) with limb showing a margin of 10 broadly acute or mucronate teeth, a distinctly bilabiate corolla, four included stamens, and a bi-carpellary pistil. The fruit consists of four nutlets.

The chief practical diagnostic differences between *Ballota hirsuta* and *Marrubium vulgare* are as follows:

1. The calyx, which in *Ballota hirsuta* is densely hairy, distinctly bi-labiate-infundibuliform with limb margin showing 10 broadly acute or mucronate teeth, whereas in *Marrubium vulgare* it is sparsely hairy, distinctly tubular with ten, bristle-like, recurved teeth.
2. The absence in *Marrubium vulgare* and presence in *Ballota hirsuta* of certain branched trichomes, the central branch of which bears a glandular head of one, two, or four cells.
3. The branched trichomes of *Ballota hirsuta* show on the average longer basal stalks, thicker walls and more rigid branches than those of *Marrubium vulgare*.
4. A number of trichomes of *Ballota hirsuta* are lignified at their bases, whereas in *Marrubium vulgare* no such lignification has been observed.

#### SALVIA N.F. (SAGE)

**Synonyms.**—*Garden-sage*, True Sage, Meadow Sage; *Fr.* Sauge; *Ger.* Salbeiblätter.

**Botanical Origin.**—*Salvia officinalis* Linné.

**Part Used.**—The dried leaf.

**Standard of Assay.**—Not less than 1.25 cc. of volatile oil from each 100 Gm. of drug.

**Limit of Impurities.**—It contains not more than 10 per cent. of the stems of the plant and not more than 2 per cent. of other foreign organic matter; it yields not more than 25 per cent. of crude fiber, not more than 10 per cent. of total ash, and not more than 1 per cent. of acid-insoluble ash.

**Habitat.**—Mediterranean regions.

**Plant.**—A perennial low shrub or subshrub from 6 inches to 1½ feet high. From an underground fibrous root system there arises a grayish, much branched, pubescent stem with branches opposite. In early summer the upper branches bear blue, rarely pink or white, bilabiate flowers followed by blackish nutlets borne in open cups.





FIG. 382.—*Salvia officinalis*. 1. Portion of plant with leaves and flowers. 2. Flower. 3. Calyx laid open. 4. Corolla laid open. 5. Ovary. 6. Part of flowering stem in fruit. 7. 8. Fruits consisting of groups of 4 nutlets. 9-12. Nutlets. 13, 14. Vertical-, and 15. Transverse section of nutlet. (After Bentley and Trimen.)

**Production and Commerce.**—The plant is cultivated in various temperate parts of Europe, Canada, and the United States from seeds, which are sown in early spring in ordinary garden soil, or from cuttings. The leaves are gathered just before or while the plant is in flower, carefully dried in the shade and marketed. The drug, in normal times, has been largely produced in Yugoslavia, Italy and Greece. It has been imported from these countries and also from Malta, Palestine, Syria, Denmark, Netherlands, France, Germany, Argentine and Mexico. Dalmatian Sage is Garden Sage grown in Yugoslavia. Greek Sage (*Salvia triloba*) is imported from Greece, the usual shipping port being Chios. Spanish Sage (*Salvia lavandulæfolia*) is imported from Mexico (although Mexico also produces official sage). The last two sages have frequently been substituted for the true sage. The average annual importations of sage into the U.S.A. have been about 1,500,000 pounds. During 1946, 1,306,652 pounds of unground sage were imported from Spain, Malta, Palestine, Syria, Argentine and Mexico.

**Culture.**—Sage can be grown as an annual or perennial. It is adapted to any well drained garden soil, but a rich clay loam containing 400 lbs. of fertilizer (either 2-10-10 or 5-8-7) per acre is desirable for best growth. Its flavor is stated to seem improved by a low nitrogen soil content. The seed may be planted in drills about  $\frac{3}{4}$  in. deep directly in the field ( $1\frac{1}{2}$  to 2 lbs. per acre) or seedlings or rooted cuttings may be first grown during late winter or early spring in a hot bed or cold frame and transplanted to the field when danger of frost has passed. If seedlings are used, they should be planted 6 to 8 inches in the rows, and the rows for plants which are grown for an annual crop should be made wide enough for cultivation. If grown as a perennial, the rows should be 3 to 4 ft. apart, and the plants should be later thinned in the rows to 2 feet. One pound of viable seed planted in a cold frame should produce from 12 to 20 thousand seedlings, sufficient for planting an acre of sage. Cultivate lightly to remove weeds. The leaves and small leafy stems are harvested just before or at the time of flowering by hand picking or with the mower, stripping the leaves from the thicker stems. They may be dried on racks in sheds or lofts with good air-circulation, being turned two to three times daily, or by artificial drying in damp weather. They are packed in burlap bags or bales for the market. The yield the first year has varied from 400 to 1000 lbs. per acre with larger crops in succeeding years when 2 or 3 cuttings may be made from the crop.

**Description.**—Leaves opposite, long-petiolate, petiole pubescent, grooved above, up to 4.5 cm. in length; laminæ elliptical, ovate-oblong or oblong-lanceolate, 2 to 10 cm. in length, 1 to 3 cm. in breadth; apex acute or obtuse; base rounded or cuneate, uneven or lobed; margin crenulate; upper surface with depressed midrib, light olive-gray to weak yellow-green and densely pubescent in young leaves; lower surface grayish or pale grayish-green, densely pubescent; venation pinnate-reticulate, the reticulations being very small; midrib and veins prominent; texture velvet-like; odor strongly aromatic on crushing; taste aromatic and bitter.

**Histology.**—Sections of the dorsiventral lamina exhibit the following structures passing from ventral to dorsal surface.

1. *Upper epidermis*, undulate with thick-walled, cutinized epidermal cells which are polygonal and with slightly wavy, beaded walls in vertical view.

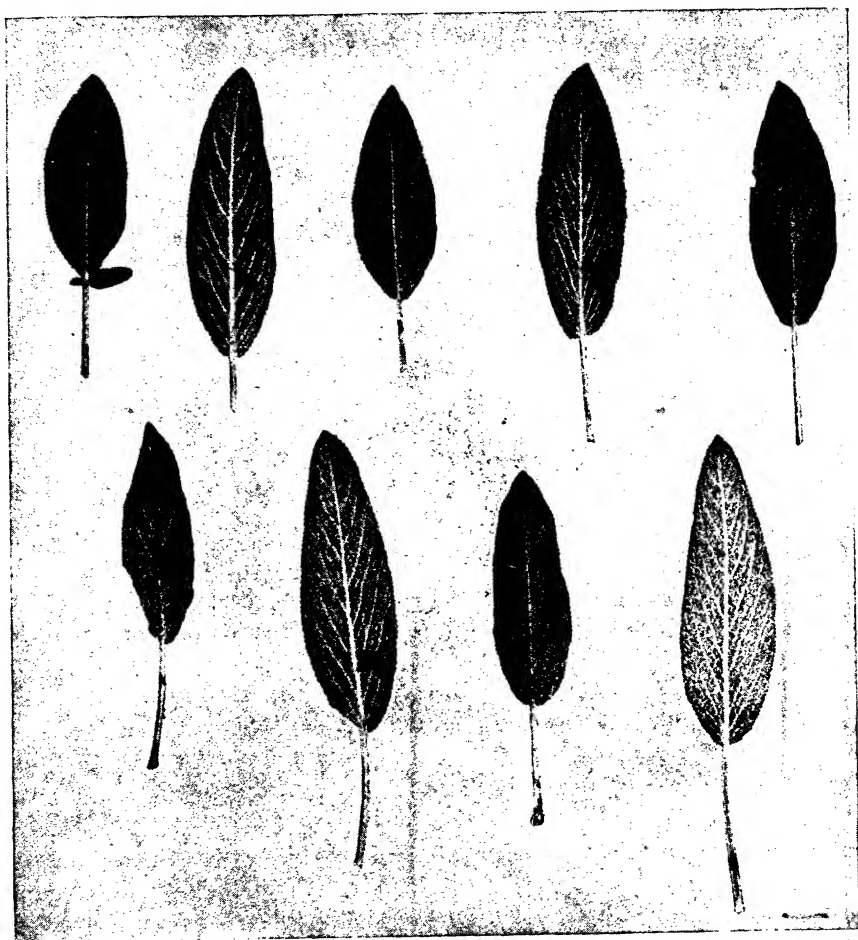


FIG. 383.—Sage Leaves (*Salvia officinalis* L.). Upper surface of leaf blades appears darker than the lower surface, the latter showing more prominent veins.

Numerous non-glandular and glandular hairs emanate from this epidermis, the non-glandular type predominating.

2. *Palisade parenchyma*, consisting of 1 or 2 layers of irregularly columnar cells containing chloroplastids.

3. *Spongy parenchyma*, a zone of 3 to 4 layers of rounded parenchyma cells, most of which contain chloroplastids, a few resin.

4. *Lower epidermis*, undulate, consisting of wavy walled epidermal cells and numerous stomata. This epidermis is densely covered with non-glandular

and glandular hairs. The non-glandular hairs found on both epidermises are uniseriate, 2- to 5-celled, the end portion being frequently reflexed. The glandular hairs include those having a 1-celled stalk and a 2-celled head, those possessing a 2- to 4-celled stalk and a 1-celled head, and still others which possess an 8-celled glandular head and no stalk.

The midrib shows from 1 to 5 layers of collenchyma beneath each epidermis and a concavo-convex group of open collateral bundles, the latter separated from each other by medullary rays usually 1 cell, rarely 2 cells in width. Some of the cells contain resin.

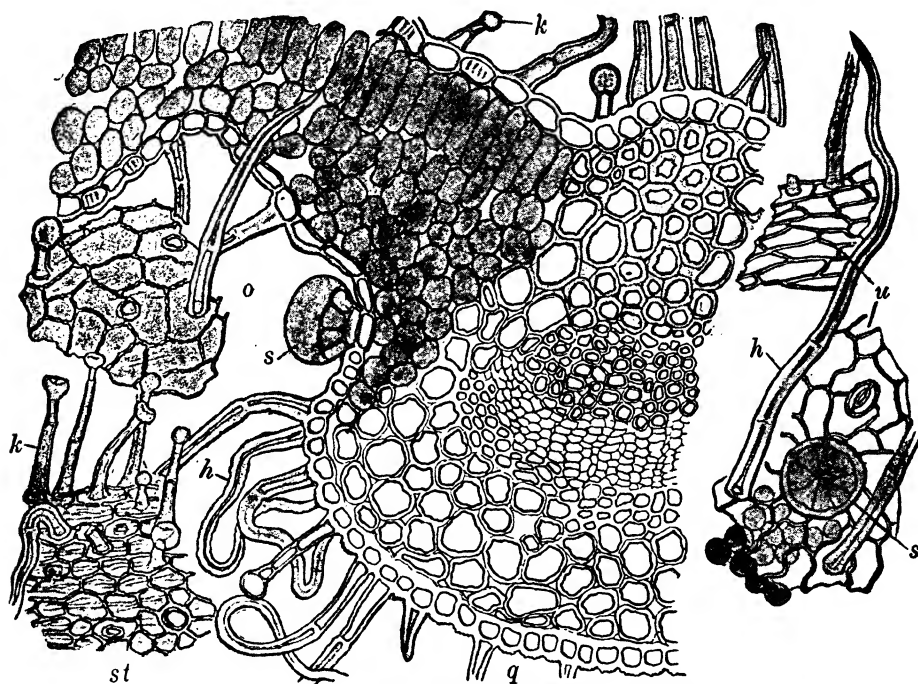


FIG. 384.—Sage (*Salvia officinalis*). *q*, transverse section of leaf blade with a portion of the midrib; *o*, upper epidermis and *u*, lower epidermis in surface section; *st*, stem epidermis in surface view; *h*, non-glandular trichomes; *k*, glandular hairs with a unicellular head; *s*, disk glandular hairs with 8-celled heads.  $\times$  about 300. (After Wasicky, "Leitfaden f.d. Pharmakognostischen Untersuchungen.")

**Powdered Sage.**—Dusky greenish yellow to light olive. Non-glandular hairs numerous, uniseriate, 1- to 5-celled, usually curved or bent, the end cell attenuate and the wall of the basal cell usually thicker and the lumen narrower than that of the other cells; glandular hairs of 3 types, those having a 2- to 4-celled stalk and a 1- to 2-celled head, those having a 1-celled stalk and a 1- to 2-celled head, and those having an 8-celled glandular head; fragments of upper epidermis with cells polygonal in surface view; fragments of the lower epidermis with cells having their vertical walls wavy and showing stomata with two neighboring cells perpendicular to the stomal opening; numerous fragments of chlorenchyma.

**Constituents.**—Up to 2.5 per cent. of a greenish-yellow *volatile oil* containing *borneol*, a sesquiterpene, pinene, thujone and cineol; bitter principles, resin and a tannin.

**Uses.**—Sage is used chiefly as a condiment but is also employed as a carminative in dyspepsia and as an ingredient in hair dressings. It is extensively employed by the meat industry as a flavoring agent in sausages and other products, and is an important ingredient in many ground spice formulæ intended for the seasoning of poultry and meats.

**Average Dose.**—4 Gm. (60 grains).

**Adulterants.**—(1) Leaves of *Salvia lavandulæfolia* Vahl, commonly known as Spanish Sage, a perennial herb indigenous to Mexico, particularly Sierra Madra, Bolanos and other towns, where it thrives 5000 to 7000 ft. above the sea level. Its leaves are oblong-lanceolate, 1 to 1½ inches long and ¼ to ½ in. broad, smaller than those of *S. officinalis* and tending to be whorled on the stems. The apex is either acute or rounded; the base subcordate or rounded; the margin nearly entire, very slightly crenulate; the surface much smoother than that of *S. officinalis*.

(2) Leaves of *Salvia triloba* Linné, commonly known as Greek Sage, a perennial herb indigenous to Mediterranean countries.

Greek Sage may readily be distinguished from Sage by the leaves usually being broader, shorter, thicker, more woolly and having a very short petiole, and a less pronounced crenulate margin and also by its odor which is characteristically aromatic. It contains up to 2.37 per cent. of volatile oil.

(3) Leaves of *Phlomis* spp. which are tomentose with stellate hairs.

(4) Sage stems. These may be detected by the presence of numerous reticulate tracheæ and crystal-bearing cells.

#### HEDEOMA (PENNYROYAL)

**Synonyms.**—American Pennyroyal, Squaw Mint, Tickweed, Stinking Balm; *Ger.* Amerikanischer Poleimünze; *Fr.* Pouliot américain.

**Botanical Origin.**—*Hedeoma pulegioides* Persoon.

**Parts Used.**—The dried leaves and tops.

**Habitat.**—North America, in woods and along roadsides.

**Plant.**—An erect, much branched, annual herb from ½ to 1 ft. in height with slender, pubescent stems, opposite, ovate to oblong-ovate leaves which are slightly serrate and about 1 in. in length. The flowers are small, occurring as verticillasters in the leaf axils. Each flower consists of a tubular-bilabiate calyx, a pubescent, purple, bilabiate corolla with an emarginate, erect, flat, upper lip and a lower lip with 3 large spreading lobes, 4 didynamous, pale blue stamens, the 2 lower ones being alone fertile, and a bicarpellate pistil. The odor is characteristically mint-like, the taste aromatic and pungent.

**Production and Commerce.**—American Pennyroyal is gathered for the market chiefly in North Carolina, Virginia and Ohio during the summer. It should be slowly dried and stored in air-tight containers.



FIG. 385.—*Hedeoma pulegioides*. 1. Upper portion of plant. 2. A flower. 3. Section of calyx. 4. Corolla laid open. (After Bentley and Trimen.)

**Constituents.**—Volatile oil containing *pulegone* ( $C_{10}H_{16}O$ ), and *hedeomol* ( $C_{10}H_{18}O$ ); tannin, etc. Pulegone also occurs in the volatile oils of *Mentha Pulegium* or European Pennyroyal, *Monarda fistulosa*, *Mentha canadensis* and *Calamintha Nepeta*. When reduced by sodium in ethereal solution, pulegone is changed to menthol.

**Uses.**—Pennyroyal is used chiefly in an infusion by the laity, as a stimulant, carminative and emmenagogue. The oil and spirit have been employed as a mosquito repellent.

**Average Dose.**—4 Gm. (60 grains).

#### SAVORY (SATUREIA)

**Synonyms.**—Summer Savory; *Ger.* Bohnenkraut; *Fr.* Sarriette.

**Botanical Origin.**—*Satureia hortensis* Linné.

**Part Used.**—The dried leaves and flowering tops.

**Habitat.**—Europe. Cultivated in Europe and North America.

**Plant.**—An annual herb with an erect branched stem attaining a height of 6 to 18 in. bearing opposite, linear-oblong to spatulate leaves and interrupted spikes of verticillasters of purple flowers.

**Description.**—Leaves nearly sessile, entire, linear-oblong to spatulate when unfolded, glandular-punctate, acute to rounded at summit, tapering at base, 12 to 35 mm. in length, 1 to 2 mm. in width, green to grayish green; flowers tubular-bilabiate, purple, up to 5 mm. long, in groups of 3 to 6 in axils of leaves; calyx campanulate, hispid on nerves, 5-toothed, its teeth subulate; corolla a little longer than the calyx, its limb 2-cleft, the upper lip erect, flat, and emarginate, the lower spreading, 3-cleft; ovary deeply 4-parted, style 2-cleft at summit; fruit an oblong nutlet; stems slender, pubescent; odor characteristically aromatic; taste warmly aromatic.

**Histology.**—Epidermis with deeply sinuous vertical walls and elliptical stomata; uniseriate, non-glandular hairs numerous, up to 6 cells with pointed distal cell, occurring on leaf, stem and calyx; numerous glandular hairs with up to 12-celled heads and 1-celled stalks.

**Constituents.**—Up to 1 per cent of *volatile oil* containing about 30 per cent of *carvacrol*, also pinene, cymene, and dipentene; pentosans, etc.

**Uses.**—In poultry seasoning and as a flavoring for soups, sauces, salads and meat and egg dishes.

#### BASIL (OCIMUM)

**Synonyms.**—Sweet Basil, Common Basil; *Ger.* Basilienmünze; *Fr.* Basilic.

**Botanical Origin.**—*Ocimum Basilicum* Linné.

**Parts Used.**—The dried leaves and flowering tops.

**Habitat.**—Tropical Asia.

**Plant.**—An annual herb with erect branched quadrangular stem rising to the height of 1 to 2 ft. and bearing opposite, ovate, entire to toothed leaves which are smooth above and hairy on the veins beneath. The flowers are small, white, sometimes tinged with purple with an unequally toothed calyx and two-

lipped corolla and are arranged in dense racemes of verticillasters. The fruit is a subglobose nutlet.

**Culture.**—Basil is a tender annual extensively cultivated as a culinary herb in the United States, Europe and India. In colder latitudes, it should be started indoors in flats, during March. The seedlings are planted out in May and set to stand about 9 inches apart in rows 1 ft. apart. The crop is cut when the plants are in flower, bunched and dried preferably in the shade or dried on racks with wire mesh bottoms in the drying house.



FIG. 386.—Stone Root (*Collinsonia canadensis* L.).  $\times \frac{1}{2}$ .

**Description.**—Sweet Basil occurs as whole and broken, often curled, leaves together with portions of the flowering and fruiting tops; leaves when entire ovate, irregularly toothed along margin, and acute at apex, rounded at base, petiolate, up to about 5 cm. in length; hairy on the veins, especially beneath; odor fragrantly aromatic; taste warmly aromatic and pungent.

**Histology.**—The most diagnostic elements are the non-glandular 1- to 2-celled hairs with broad base, pointed end and finely warty cuticle, and the glandular hairs with 2- to 4-celled heads.

**Constituents.**—Volatile oil containing *cineol*, pinene, methyl chavicol, *d-camphor* and *ocimene* ( $C_{10}H_{16}$ ).

**Uses.**—In the flavoring of meats, poultry, soups and stews, tomato dishes, etc.

#### COLLINSONIA

The dried rhizome and rootlets of *Collinsonia canadensis* L. commonly known as Stone Root, Knot Root and Horse Balm, a perennial herb indigenous to eastern and central North America, contains resin, tannin, starch and wax. The drug occurs as a branched, knotty, tubercular rhizome with many stem scars and wiry rootlets; externally grayish-brown; internally grayish-white; fracture hard and tough; odor indistinct; taste bitter and nauseous. It is



used as a diuretic, diaphoretic, tonic and astringent. Average Dose, 2 Gm. (30 grains).

#### SOLANACEÆ (NIGHTSHADE FAMILY)

Stems herbaceous, rarely shrubby or arborescent, frequently with bicollateral bundles. Leaves alternate, exstipulate, entire or more or less lobed, rarely compound; often glandular-hairy. Flowers in cymes; regular or rarely irregular (Petunia, Tobacco spp.), pentamerous, perfect, synphyllous; calyx green (rarely petaloid), rotate to tubular, usually persistent and accrescent; corolla rotate



FIG. 387.—*Atropa Belladonna*. (Photograph by Kilmer.)

(Solanum), to tubular (*Atropa*), to funnel-shaped (Tobacco), and so (1) open to all comers, or (2) to bees or wasps, or (3) to butterflies, moths; color, greenish-yellow, or greenish-white to white, to pink, crimson, purple, rarely blue; stamens five, epipetalous, hypogynous, along with style usually forming nectar glands. Filaments short to long, anthers dehiscing longitudinally or by apical pores; pistil bicarpellate, syncarpous, with or without nectar girdle; superior ovary, two-celled with central placentation; ovules numerous; style more or less elongate with bilobed or bifid stigma. Fruit, a capsule. (Tobacco, Thorn-apple) dehiscing longitudinally or transversely (Henbane); or a berry (belladonna, potato, egg-plant, tomato, red pepper). Seed albuminous, with curved embryo. Many of the plants contain alkaloids.

Among the histological features of this family are the following: The presence of intraxylary soft bast in the stems and leaves frequently accompanied by sclerenchyma fibers. This inner margin of the intraxylary phloem is often strengthened by sclerenchyma. This sclerenchyma is either in the form of a continuous ring at the margin of the pith or as isolated elements or groups of these in the medullary sheath. Isolated groups of sclerenchyma fibers occur in the pericycle. An occasional stone cell is to be found among these fibers in the genus *Brunfelsia*. The secondary phloem is commonly devoid of bast fibers. Internal secretory organs are absent. The tracheæ exhibit simple pits, bordered pores and often reticulate markings. The stomata are usually sur-



FIG. 388.—Root system of *Atropa Belladonna*. (Photograph by Kilmer.)

rounded by 3 to 4 neighboring cells, but in *Brunfelsia*, *Juanulloa* and *Dyssochroma* two neighboring cells occur. Uniseriate non-glandular hairs and glandular hairs are frequent. Peltate and tufted hairs occur in the genus *Solanum*. Calcium oxalate occurs in the form of rosette aggregates, solitary crystals and twin prisms. Microcrystals are usually present.

#### BELLADONNA ROOT N.F. (BELLADONNÆ RADIX)

**Synonyms.**—*Deadly Nightshade Root*, Black Cherry Root, Dwale Root; *Ger.* Belladonnawurzel; *Fr.* Racine de Belladonne.

**History.**—Belladonna is derived from two Italian words (*bella*, beautiful and *donna*, lady) and alludes to the use of its fruits by Italian ladies for dilating

the pupils of their eyes, so improving their appearance. It was probably known to Dioscorides who, under the name of "*Strychnon manikon*," described its dark flowers and round black fruits. It is referred to in the "*Grand Herbier*" published in Paris about 1504 as "*Solastrum furiale*," a name given it by Saladinus of Ascoli in his "*Compendium aromatariorum*," in 1488. Belladonna leaves were introduced into the London Pharmacopœia of 1809 and into the U.S.P. of 1820. The root first became official in the U.S.P. of 1860 following its commendation by Peter Squire, a noted London pharmacist, who prepared from it a tincture to be used in a liniment for the treatment of neuralgic pains. It

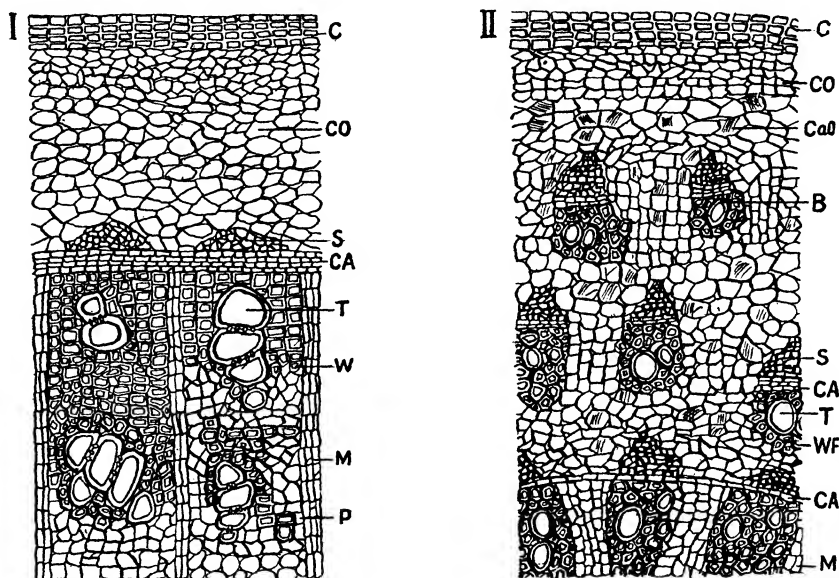


FIG. 389.—I, Transverse section of Belladonna root (semi-diagrammatic). Cork (C); cortex (CO); sieve tissue (S); cambium (Ca); tracheæ (T); wood fibers (W); medullary ray (M); wood parenchyma (P). The older the root of belladonna, the more wood fibers present. II, Transverse section of poke root (*Phytolacca americana*). Cork (C); cortex (CO); raphides of calcium oxalate (CaO); open collateral fibrovascular bundle (B); phloem (S); cambium (CA); trachea (T) and wood fibers (WF) of xylem; medullary-ray (M).

remained in every subsequent revision of the U.S.P. until 1946 when it was admitted to the N.F. VIII.

**Botanical Origin.**—*Atropa Belladonna* Linné.

**Part Used.**—The dried root.

**Standard of Assay.**—It yields not less than 0.45 per cent. of the alkaloids of Belladonna root.

**Limit of Impurities.**—It contains not more than 10 per cent. of its stem bases and woody crowns and not more than 2 per cent. of foreign organic matter other than stem bases or woody crowns. It yields not more than 4 per cent. of acid-insoluble ash.

**Habitat.**—Central and Southern Europe and Asia Minor.

**Plant.**—A bushy perennial herb with dichotomously branched stems. Leaves alternate, broadly ovate to ovate, entire or nearly entire along margin,

acute at summit, tapering at base, dark green. Flowers solitary or rarely in clusters of 2 or 3, axillary and drooping; calyx deeply 5-cleft; corolla dull greenish-purple or reddish-purple, campanulate, with 5 broad, spreading and recurved

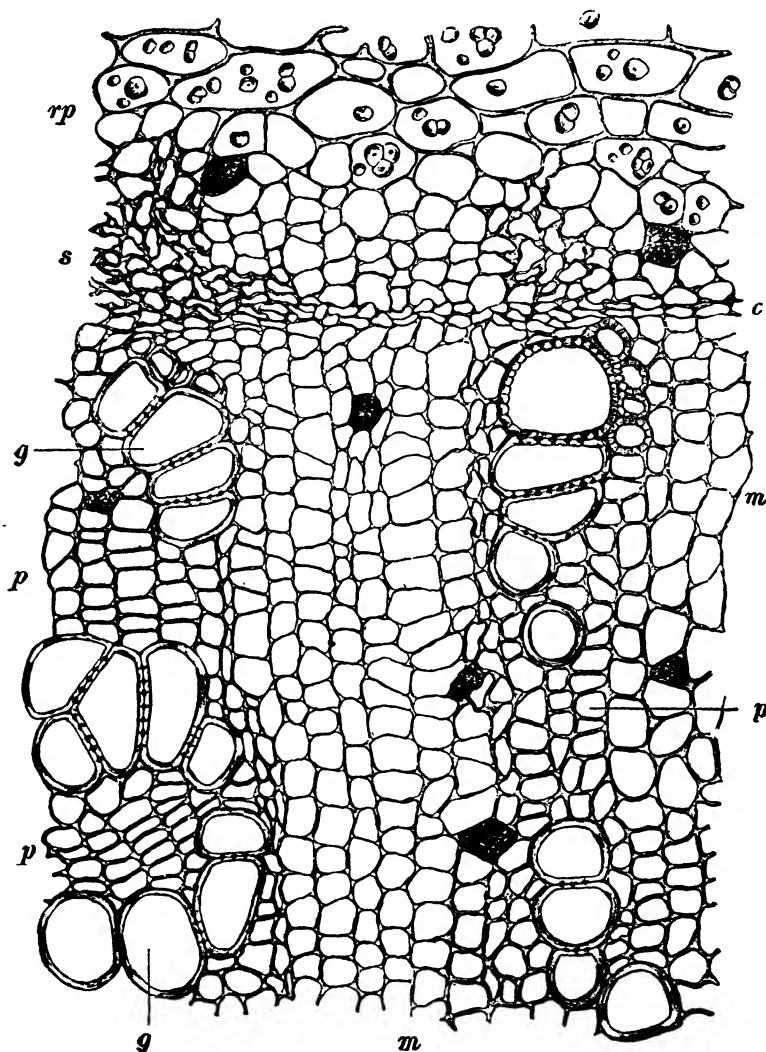


FIG. 390.—Belladonna Root. Transverse section of portion showing inner part of cortex, the phloem, cambium and secondary xylem. *rp*, cortical parenchyma; *s*, phloem strand; *c*, cambium; *g*, tracheæ; *p*, wood parenchyma; *m*, medullary ray. The dark contents in some of the cells are masses of micro-crystals. (From Greenish, after Moeller.)

lobes; stamens 5, epipetalous; style exserted; stigma knob-like. Fruit a sub-globular black berry with persistent calyx.

**Production and Commerce.**—The roots are plowed from the ground in the fall. The larger roots are split and dried. The drug is obtained largely from

plants grown in this country, and Central Europe. It should be preserved against insect attack. (See also *Belladonna Leaf*.)

**Description.**—It occurs as cylindrical or somewhat tapering segments of roots frequently cut longitudinally, and often with a few stem bases, either attached or separate. Roots from 0.5 to 4 cm. thick, externally weak brown to moderate yellowish brown, longitudinally wrinkled, the periderm frequently abraded and thus showing lighter patches; fracture nearly smooth, mealy, emitting a puff of dust consisting chiefly of starch grains; internally pale yellow to light yellowish brown with a distinct cambium zone and yellowish wood wedges; nearly inodorous, taste sweet, afterwards bitter and strongly acrid. Stem fragments light-brown or greenish-brown; finely longitudinally wrinkled, with annulations due to leaf scars and usually exhibiting a hollow pith.

*Belladonna Root* possesses a peculiar strongly narcotic odor on boiling.

**Histology.**—Transverse sections of the root, cleared by warming in chloral solution exhibit the following characteristics:

1. *Cork* composed of several rows of tangentially-elongated, thin-walled cork cells.
2. *Phellogen* (cork cambium) of more or less collapsed meristematic cells.
3. *Secondary cortex* of cortical parenchyma cells most of which are filled with starch and many of which possess a grayish or black aspect, due to the presence of numerous micro-crystals. The dark crystal cells are more numerous in younger roots. The parenchyma cells have pitted walls.
4. *Phloem*, a relatively narrow zone of sieve tube and phloem cell masses separated by starch and microcrystal-bearing phloem-rays. The sieve tubes and phloem cells may readily be distinguished from the cells of the cortex region by their smaller size. No bast fibers occur in this region.
5. *Cambium*, a prominent ring of somewhat collapsed meristematic cells.
6. *Xylem*, taking up the central and greater area of the section. This is seen to be composed of radially elongated xylem strands separated by broad starch and micro-crystal bearing xylem rays. Each xylem patch is composed of a matrix of wood parenchyma in which are to be observed more or less radially elongated groups of tracheæ with thickened yellowish walls. Adhering to these are usually a few tracheids with thickened yellowish walls. In old woody roots, wood fibers replace considerable of the wood parenchyma. Some of the cells of the wood parenchyma and medullary rays possess a grayish or blackish appearance. These contain sphenoidal micro-crystals. The medullary rays are 1 to 5 cells wide.

Transverse sections mounted in water show that the majority of the parenchyma and medullary-ray cells are filled with starch.

Longitudinal-radial sections mounted on chloral solution show broad tracheæ with ellipsoidal bordered pores, tracheæ with simple pores, and reticulate markings, pitted tracheids, elongated and pitted wood parenchyma often associated with somewhat wavy-walled wood fibers having oblique slit-like pores. The parenchyma cells of the cortex appear somewhat axially elongated. Micro-crystals are visible in a number of parenchyma cells scattered throughout the section.

Sections of the stem bases show a circle of bi-collateral bundles, both phloem regions of each bundle exhibiting thin-walled, slightly lignified fibers, arranged singly and in small groups along their outer edges.

**Powdered Drug.**—Pale brown to weak yellow; nearly odorless when dry, but having a characteristic odor when moistened, and a sweet, then bitter and acrid taste; starch grains numerous, simple and compound, the simple grains usually from 3 to  $15\mu$ , but occasionally up to  $30\mu$  in diameter, and with a distinct, somewhat excentric hilum; the compound grains 2- to 6-compound, the individual starch grains spheroidal, plano-convex or polygonal and exhibiting distinct polarization crosses in the larger grains; fragments of parenchyma, some of the cells of which contain numerous sphenoidal microcrystals the latter also occurring free in the powder and from 3 to  $10\mu$  in length; fragments of cork, fragments of tracheæ and tracheids, with bordered pores, simple pores or reticulate markings sometimes associated with wood fibers. If the powder includes stem bases, few, slightly lignified pericyclic fibers may be observed.

**Constituents.**—The alkaloids *hyoscyamine*, *atropine*, *apoa tropine*, *belladonnine* and *scopolamine* (hyoscyne); charysotropic acid, starch, etc. Hyoscyamine is the principal constituent. Atropine, apoatropine and belladonnine are believed to be formed in the process of extracting hyoscyamine.

*Hyoscyamine*,  $C_{17}H_{23}O_3N$ , crystallizes from dilute alcohol in long silky needles, is levorotatory in solution, soluble in alcohol, chloroform and benzene and is readily converted into the racemic modification, atropine, by treating its cold alcoholic solution with a dilute caustic alkali.

*Atropine*,  $C_{17}H_{23}O_3N$ , chiefly obtained from belladonna is composed of the isomers, dextro- and levo-hyoscyamine into which it separates when dissolved in water. It is an extremely poisonous, optically inactive alkaloid. It occurs in white colorless crystals, very slightly soluble in water, very soluble in alcohol and chloroform, less soluble in ether. Its salts are largely crystalline and soluble in water.

*Apoatropine* (Atropamine),  $C_{17}H_{21}O_2N$ , is the anhydride of atropine. It is optically inactive like atropine but is devoid of mydriatic action.

*Belladonnine*,  $C_{17}H_{21}O_2N$ , is an isomeride of apoatropine, which can be obtained from the latter by heating it with hydrochloric acid for 8 hours in sealed tubes (Hesse).

**Uses.**—As an anodyne, antiasthmatic, mydriatic, to prevent the griping of irritant cathartics, to relieve pain, to relax overcontracted smooth muscle, decrease secretion, for urinary incontinence, night sweats of phthisis, etc. Preparations of Belladonna root, especially the extract, have been effectively employed in the treatment of post-encephalitic Parkinsonism. The alkaloid atropine and its sulfate are used to diminish secretion of mucus, saliva and sweat, to depress sensory nerve endings and so lessen pain, to relax overcontracted smooth muscle in asthma, spastic constipation, etc., in spasmodic nervous conditions as whooping cough, etc., to check excessive pneumogastric activity as in partial heart block, to stimulate the circulation, also in spasmodic dysmenorrhea, biliary and renal colic, and in the treatment of poisoning by various

depressants like opium, chloral, etc. They are also employed in ophthalmology as mydriatics and cycloplegics, and in inflammatory conditions of the eye, as iritis and keratitis. They dilate the pupil, paralyze accommodation, increase intraocular tension and lessen pain.

*Homatropine Hydrobromide*, U.S.P. ( $C_{16}H_{21}O_3N.HBr$ ) is the hydrobromide of a synthetic alkaloid prepared from tropine and mandelic acid. It occurs

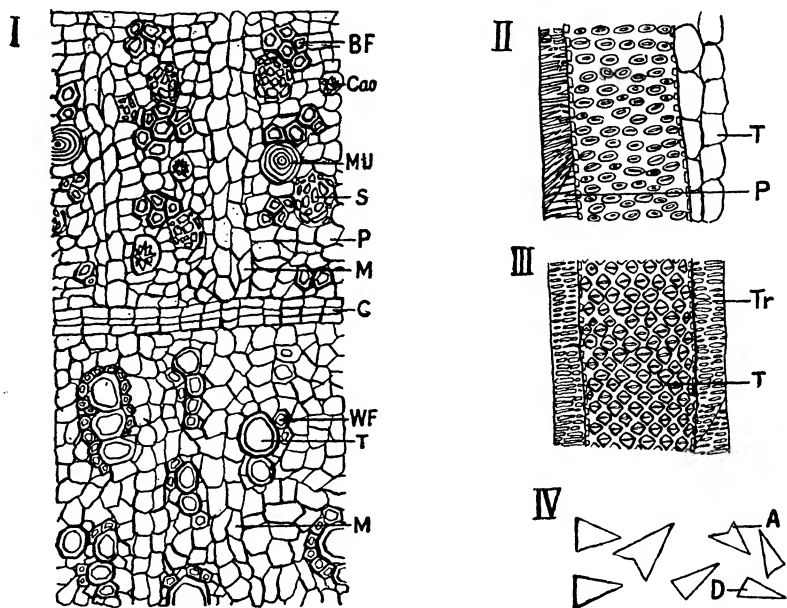


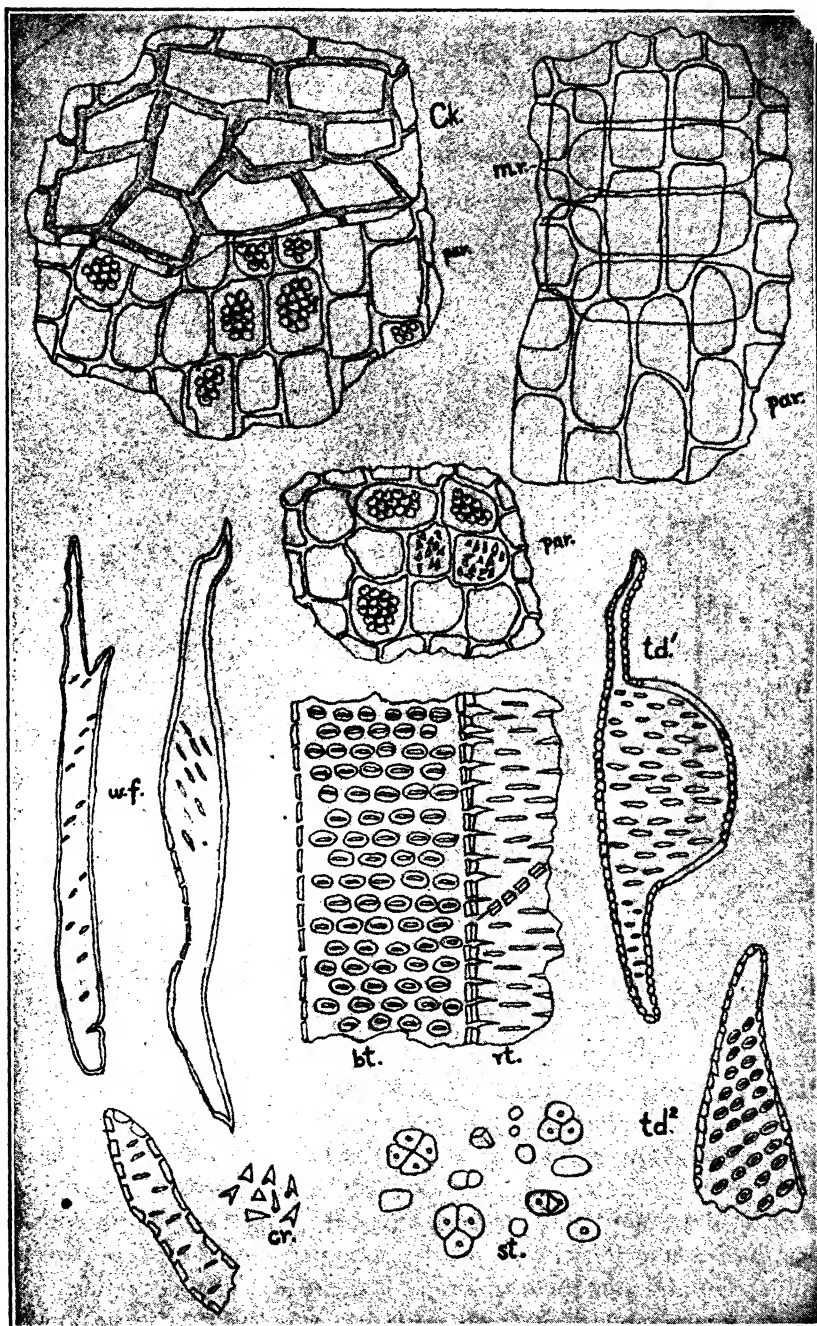
FIG. 391.—I, Transverse section of *Atropa* showing bast fibers (BF); rosette aggregates of calcium oxalate (CaO); mucilage sacs (MU); sieve tissue (S); phloem parenchyma (P); cambium (C); wood fibers (WF); tracheæ (T) and medullary-rays (M). II, Longitudinal section through bundle region of *Belladonna* root. Reticulate tracheid (P); wood parenchyma (T). Between T and P will be noted a broad trachea with ellipsoidal shaped bordered pores. III, Longitudinal section through portion of bundle of *Phytolacca* root. Trachea with diamond shaped bordered pores (T); reticulate trachea (Tr). IV, Micro-crystals from belladonna. (A) Arrow shaped; (D) deltoid.

in colorless crystals or as a white, crystalline powder. Like atropine it is extremely poisonous. It is used as a mydriatic and cycloplegic and is preferred to atropine for ophthalmoscopic examinations, on account of the brief duration of the mydriasis it induces. Av. dose, 0.0005 Gm. ( $\frac{1}{20}$  grain).

**Average Dose.**—0.045 Gm. ( $\frac{3}{4}$  grain); of Scopolamine (Hyoscine) Hydrobromide U.S.P., 0.5 mg. ( $\frac{1}{20}$  grain); of Atropine, U.S.P., 0.4 mg. ( $\frac{1}{50}$  grain); of Atropine Sulphate U.S.P., 0.5 mg. ( $\frac{1}{20}$  grain).

**Preparations.**—Belladonna Root Fluidextract N.F., 0.05 cc. ( $\frac{3}{4}$  minim); Belladonna Liniment N.F.; Belladonna Plaster, N.F. (from extract of root).

**Adulterants.**—(1) Root of *Phytolacca americana* (Poke Root). This root has a tough fibrous fracture and shows a series of concentric circles of open collateral fibro-vascular bundles. It also possesses tracheæ with diamond



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soil  
r

FIG. 302.—Powdered Belladonna Root. *Ck.*, cork; *par.*, parenchyma; *mr.*, medullary-ray; *w.f.*, wood fibers; *bt.*, trachea with ellipsoidal bordered pores; *rt.*, reticulate tracheae; *td<sup>1</sup>*, tracheid with simple slit-like pores; *td<sup>2</sup>*, tracheid with bordered pores; *st.*, starch grains; *cr.*, microcrystals. (Drawing by Samuel Mushlin.)



shaped bordered pores, some parenchyma cells with micro-crystals, others with raphides of calcium oxalate. (See Fig. 389.)

(2) Unpeeled Marshmallow roots. These differ from Belladonna root in possessing numerous sclerenchyma fibers, mucilage sacs, ellipsoidal starch grains, and a few rosette crystals of calcium oxalate. (See Fig. 391.)



FIG. 393.—*Atropa Belladonna*. Young potted plant showing the character of the leaves.

(3) Rhizomes of *Scopolia carniolica*. These are devoid of tracheæ with bordered pores, but possess characteristic, often barrel-shaped, reticulate tracheæ. (See *Scopolia*, p. 763).

#### BELLADONNA LEAF U.S.P. (BELLADONNÆ FOLIUM)

**Synonyms.**—*Deadly Nightshade Leaf*, *Belladonnæ folium P.I.*, Black Cherry Leaf, Dwale; Death's Herb; *Ger.* Tollkraut, Belladonna Blätter; *Fr.* Morelle furieuse, Feuilles de Belladonne.

**Botanical Origin.**—*Atropa Belladonna* Linné.

**Part Used.**—The dried leaf and flowering or fruiting top with branches.

**Standard of Assay.**—Not less than 0.3 per cent. of the alkaloids of Belladonna Leaf.

**Limit of Impurities.**—Not more than 3 per cent. of belladonna stems over 10 mm. in diameter; it yields not more than 3 per cent. of acid-insoluble ash.

**Production and Commerce.**—Probably more Belladonna is grown in this country than any other drug plant. It is also extensively grown in Yugoslavia and other Central Europe districts, in England and India. The plants are propagated either from seeds or roots. The seeds should be sown in seed boxes in the hot house in December and the young seedlings transferred to flats or pots in April. Potting produces a firmer root. When sufficiently strong, the seed-

lings should be set out 3 feet apart in each direction. The best soil is deep, well drained, moist loam, which should be well limed. Too much moisture in the soil is injurious. In propagating from roots, either whole roots may be employed or the crowns may be divided. These are planted in holes dug in the ground about 3 feet in each direction and are covered with an inch or two of soil. In



FIG. 394.—*Atropa acuminata* Royle ex Lindley. Leaf and flowering branches.  $\times \frac{1}{3}$ . This Indian species is a close relative of *Atropa Belladonna* and with the latter yields the Belladonna of the British Pharmacopœia.

localities where frost penetrates deeply into the ground, the roots should be removed in the fall and replanted in the spring. The plants should be cultivated to free the soil from too many weeds. Two crops of leaves can be gathered from first year plants. Two to four cuttings may be taken from second or third year plants. The leaves should be kept in the shade and dried with the

aid of artificial heat. It is well to start with a moderate heat and gradually increase to  $140^{\circ}$  or  $150^{\circ}$  F. and then gradually decrease. Leaves dried artificially are generally of a richer green color and so usually demand a higher price than those dried in the sun. They are not necessarily richer in alkaloids than leaves which are sun dried and so of a more brownish-green color.

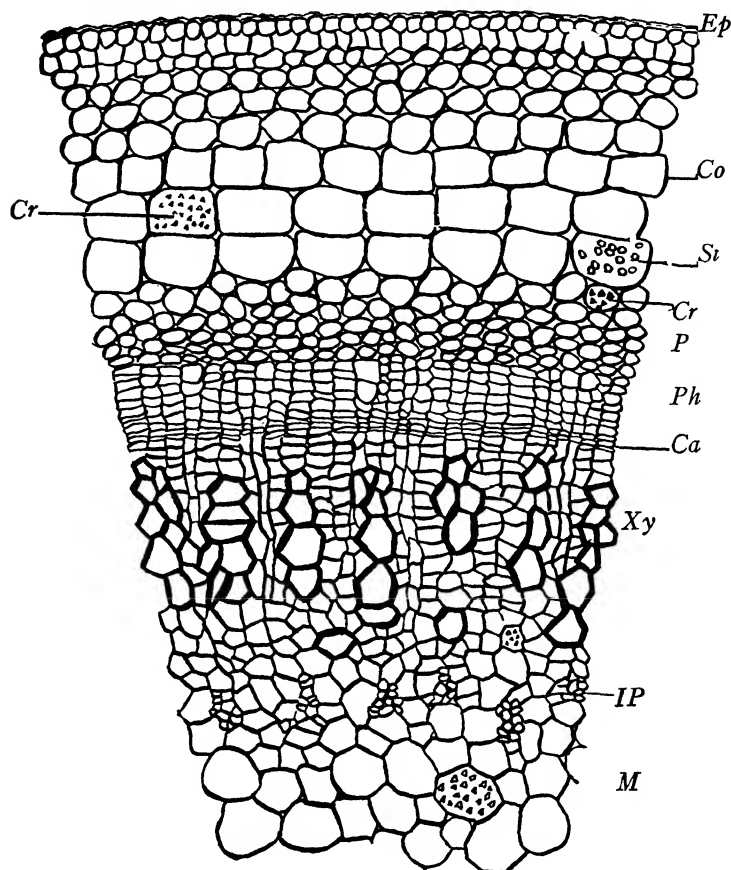


FIG. 395.—Indian Belladonna. Transverse section of stem of *Atropa acuminata* Royle ex Lindley,  $\times 30$ . Ep, epidermis; Co, cortex; St, starch; Cr, microcrystals; P, pericycle; Ph, phloem; Ca, cambium; Xy, xylem; IP, internal phloem; M, pith, showing one of the cells containing microcrystals.

Germination of Belladonna seed may be hastened by placing the seeds in concentrated sulfuric acid for exactly 45 seconds, then plunging the seeds immediately into a large amount of cold water in a glass or porcelain container and stirring with a wooden stick or glass rod. The seeds should then be strained off on a coarse cloth and repeatedly washed with water to remove all traces of the acid. Planting should immediately follow this treatment.

Most of the drug used in the United States is obtained from plants cultivated in this country. On account of the great demand considerable of the drug before World War II was imported in large bales from Central Europe. During

1940, the imported drug came from Hungary, Italy, Belgium, Yugoslavia, Rumania, and Spain. From 1941 to 1946 practically all of the *Belladonna* used in this country was grown here and considerable was supplied to our allies. During 1946 only 10,453 lbs. of *Belladonna* were imported from Europe.

**Description.**—Usually as matted leaves and tops with stem segments; leaves crumpled or broken; when soaked in water and spread out, the entire leaves from 6 to 20 cm. in length, 4 to 12 cm. in breadth; broadly ovate, slightly hairy,

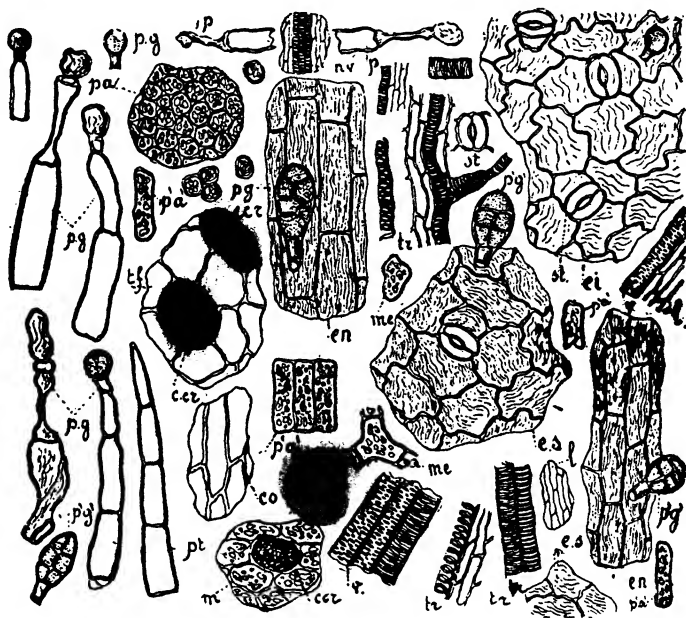


FIG. 396.—Powdered *Belladonna* Leaves,  $\times 210$ . *c*, *cr*, Leaf parenchyma cells with dark masses of microcrystals. *co*, Collenchymatous cells from cortical tissues of midrib. *ei*, Lower epidermis with striated cuticle and stomata. *en*, Epidermis over the veins with striated cuticle. *es*, Upper epidermis with striated cuticle and occasional stomata. *l*, Lepidome. *me*, Branching cells of spongy parenchyma. *nv*, Fragment of small vein. *pa*, Palisade parenchyma cells in surface view. *p'a'*, Palisade cells in longitudinal view. *pg*, Glandular hairs, long and short, with unicellular and multicellular heads. *st*, Stomata, surrounded by 3 or 4 cells, one of which is smaller than the others. *tf*, Cortical tissues of the midrib. *tr*, *v*, Tracheids and vessels. (From Sayre after Greenish and Collin.)

summits acute to acuminate, margins entire, narrowed into the long petioles; light green to moderate olive green; flowers with yellowish-purple to livid purple campanulate corollas with 5 small, reflexed lobes; fruits nearly globular, 2-celled berries, subtended by a 5-lobed persistent calyx and with many small flattened, somewhat reniform seeds; odor somewhat tobacco-like, especially on moistening; taste bitter and acrid. Stems of variable length and not over 10 mm. in diameter, longitudinally wrinkled, older parts smooth and usually hollow, younger parts flattened and hairy.

**Histology.**—Transverse and surface sections of the leaves may be prepared by placing the dried material in a moist chamber for 24 hours before the sections are cut. The epidermis may be readily separated by gently warming small

fragments in solution of chloral hydrate or 1 per cent. sodium or potassium hydrate in a watch crystal for about 5 minutes, transferring to slide and exerting slight pressure on the cover slip with a rotary movement.

Both *epidermises*, as observed in vertical view, are composed of large wavy-walled epidermal cells with stomata and *striated cuticle*. Over the veins, however, the epidermal cells have rectilinear walls. There are a larger number of stomata on the lower than on the upper surface. Each stoma is surrounded



FIG. 397.—*Scopolia carniolica*. Branch, leaves and flower. An adulterant for Belladonnae Folium.

by 3 or less often 4 neighboring cells, one of which is smaller than the rest. Non-glandular and glandular hairs occur as outgrowths from both epidermises. The former are thin-walled, uniseriate, of from 2 to 6 cells, occasionally showing terminal branching. The glandular hairs are of two kinds; one possesses a 2- to 4-celled stalk and a 1-celled head, the other a 1-celled stalk and a pluricellular head. Stomatal index: upper epidermis, 2.9; lower epidermis, 17.6.

The *mesophyll* between the epidermises exhibits a layer of short palisade cells directly beneath the upper epidermis and several layers of spongy parenchyma. Most of these cells contain chloroplastids but grayish-black cells may be observed scattered here and there. These are filled with sphenoidal

microcrystals (crystal sand). The petiole, *midrib* and *veins* show bicollateral bundles. Palisade ratio: 5 to 7.

The *stems* are characterized by a circle of short bicollateral bundles, long, thin walled, slightly lignified pericyclic fibers, and cortical, ray and pith parenchyma possessing many cells containing microcrystals.

**Powdered Drug.**—Light olive brown to moderate olive green; fragments of mesophyll containing grayish to grayish-black, to black cells scattered amongst chlorophyll parenchyma and containing microcrystals; fragments of epidermis with large, wavy-walled cells and stomata, the latter surrounded by 3 or 4 neighboring cells, one of which is smaller than the others; hairs few and generally broken, the non-glandular being uniseriate and 2 to 5 cells in length, the glandular with stalks of 1 to 4 cells (usually 1-3) and 1- to many-celled heads; fragments of flowers and fruits; pollen grains few with 3 furrows; fragments of stem tissues with characteristic slightly lignified bast fibers, annular, spiral, reticulate and bordered pore tracheæ; fragments of seed coats with convolute, thickened cell walls and rosette aggregates of calcium oxalate when powder includes Belladonna fruit.

**Constituents.**—The alkaloids, *hyoscyamine* (lævorotatory), *atropine* (optically inactive), *belladonnine*, *scopolamine* (hyoscyne); chrysotropic acid, etc. Hyoscyamine is the chief constituent. The other alkaloids are thought to be formed from it in the process of extraction.

**Uses.**—See under Belladonna root. Extract of Belladonna, prepared from Belladonna leaves, is used as an ingredient in Pills of Aloin, Strychnine and Belladonna, Pills of Aloin, Strychnine, Belladonna and Ipecac, Pills of Aloin, Strychnine, Belladonna and Cascara and Compound Pills of Cascara, in Belladonna Ointment, etc.

**Average Dose.**—60 mg. (1 grain).

**Preparations.**—Belladonna Leaf Fluidextract N.F., 0.06 cc. (1 minim); Belladonna Extract U.S.P. (pilular and powdered), 15 mg. ( $\frac{1}{4}$  gr.). Belladonna Tincture U.S.P., 0.6 cc. (10 minims); Belladonna Ointment U.S.P. (from Pilular Ext.).

**Adulterants.**—(1) Poke Leaves, detected by raphides of calcium oxalate; in addition to micro-crystals (2) *Solanum nigrum* or Black Nightshade leaves and tops. The leaves of this plant are ovate and wavy-toothed, its corolla white and rotate. Glandular hairs were absent on the leaves examined; (3) Malva Leaves, detected by numerous stellate hairs and mucilage cells; (4) Scopolia Leaves and tops, detected by characteristic reticulate tracheæ, more lanceolate leaves, and short calyx tubes each containing a nearly spherical pyxis.

## SCOPOLIA

**Synonyms.**—Scopola, Belladonna Scopola; *Ger.* Radix Scopolizæ.

**Definition.**—The dried rhizome of *Scopolia carniolica* Jacq. (Fam. *Solanaceæ*).

**Plant.**—A perennial herb indigenous to Europe, especially abundant in the Eastern Alps and Carpathians. Leaves ovate to ovate-lanceolate, acuminate; fruit a pyxis enveloped by a calyx which has short lobes.

**Description.**—Rhizome horizontal, subcylindrical, somewhat tortuous, up to 12 cm. long and 15 mm. in diameter, frequently sliced lengthwise; externally grayish-brown, longitudinally furrowed, slightly annulate with numerous circular stem scars, lower portion with root scars and remnants; fracture short and mealy; internally whitish or light brown, bark 1 mm. or less in thickness; wood slightly radiate; odor slight; taste starchy, sweetish, acrid.



FIG. 398.—*Scopolia* rhizomes. Note the large circular stem scars, the small circular root scars and the annulations.  $\times 1\frac{1}{4}$ .

**Histology.**—Similar to *Belladonna* Root except for the absence of tracheæ with elliptic-shaped bordered pores and presence of characteristic barrel-shaped reticulate tracheæ and pith.

**Constituents.**—About 0.6 per cent. of total alkaloids, including *atropine*, *hyoscyamine* and *scopolamine*.

**Uses.**—A commercial source of scopolamine and hyoscyamine. At times it has been used in the manufacture of belladonna plaster. The fluidextract and extract were official in U.S.P. VIII. Its action is similar to belladonna but more narcotic because of the presence of a greater amount of scopolamine.

**Average Dose.**—0.045 Gm. ( $\frac{3}{4}$  grain).

#### STRAMONIUM U.S.P. (STRAMONIUM)

**Synonyms.**—*Jamestown Weed*, *Jimson Weed*, Thorn Apple, Apple of Peru; *Ger.* Stechapfel, Dornapfel; *Fr.* Pomme-épineuse, Stramoine.

**Botanical Origin.**—*Datura Stramonium* Linné (including *D. Tatula* Linné).

**Part Used.**—The dried leaf and flowering or fruiting parts with branches.

**Limit of Impurities.**—Not more than 3 per cent. of stems over 8 mm. in diameter; it yields not more than 4 per cent. of acid-insoluble ash.

**Standard of Assay.**—Not less than 0.25 per cent. of the alkaloids of Stramonium.

**Habitat.**—Asia. Naturalized in fields, waste places and along roadsides in the United States, Canada and Europe.



FIG. 399.—Leaf of *Datura Stramonium* L.  $\times \frac{1}{2}$ .

**Plant.**—*Datura Stramonium* is an annual, rank smelling herb attaining a height of from 1 to 1.6 m. Its stem is glabrous and divides into 2 or 3 green branches, which in turn bifurcate and bear alternate inequilaterally-ovate,



acuminate leaves with sinuate-dentate margins. The flowers appear in the forks of the branches on short peduncles. Each consists of a green, prismatic, 5-toothed calyx, a white funnel-shaped corolla with 5 teeth, epipetalous stamens and a bicarpellate pistil whose ovary is 4-celled below, 2-celled near the top. The fruit is a prickly, 4-valved capsule, the lower prickles of which are mostly shorter than those above. The seeds are flattened, reniform, brownish-black, with white, oily albumen surrounding an embryo which is curved parallel to the seed margin.

*Datura Tatula* Linné, is now believed to be a form or variety of *D. Stramonium*. It closely resembles the former species in habit, differing mainly from it in having purplish stems, lavender colored flowers, and capsules which are nearly equally prickly.

**Production and Commerce.**—Stramonium grows abundantly as a weed on waste lots and along roadsides in the eastern and central sections of this country. It is cultivated on drug farms in several sections of the United States, Germany, France and Hungary. The plants may be propagated from seeds sown early in the spring in drills about 3 feet apart. When sufficiently strong the young plants may be transplanted to stand 2 feet apart in rows. Cultivation is necessary. The leaves are gathered while the plants are in full flower and dried in the shade at a temperature of 100° to 110°F. They are then baled for shipment. Stramonium is collected for the market in large amounts in the lower Mississippi valley and North Carolina. It has also been imported in large amounts from Argentina since the early part of World War II. The imported article has been shipped in burlap bags from Argentina, Mexico, India, Hungary, Germany, Italy, England, Algeria and Tunisia. Large acreages of Stramonium are now being grown in various parts of the United States. The domestic cultivated crop has been for the most part of higher quality and potency than the foreign product.

**Description.**—The drug occurs as more or less matted together, wrinkled and crushed leaves and stem fragments or in the loose condition. \Leaf, when entire, up to 30 cm. in length, with petioles up to 8 cm. in length; lamina inequilaterally ovate or triangular-ovate,\*summit acute or acuminate, base unequal, margins sinuate-dentate; the sinuses rounded; frequently with small circular perforations, which may have become filled with or surrounded by cork; surfaces usually sparsely hairy, especially upon the veins; color of both surfaces grayish green to light olive brown to dusky olive green. \Flowers solitary in the forks of the branches on a short pedicel; calyx green, 5-toothed; corolla white or purplish, plicate, infundibuliform; stamens 5, epipetalous; pistil bicarpellate with a conical ovary covered with short, stiff emergences. Stems light olive-brown to purplish-brown, longitudinally wrinkled and furrowed, often flattened. Odor characteristically heavy and narcotic; taste unpleasant, and nauseous.

**Histology of *Datura Stramonium* Leaves.** Transverse sections cut through the lamina including the midrib and mounted in chloral solution show the following peculiarities:

1. *Midrib*, convex above and more greatly convex below. In the center is to be noted a concavo-convex meristele of bi-collateral bundles the phloem regions of which are devoid of bast fibers. The xylem regions of the bundles are provided with rather broad tracheæ. Directly beneath the epidermis of both upper and lower surfaces will be found several layers of collenchyma cells. Between the collenchyma and the meristele occurs parenchyma tissue, some

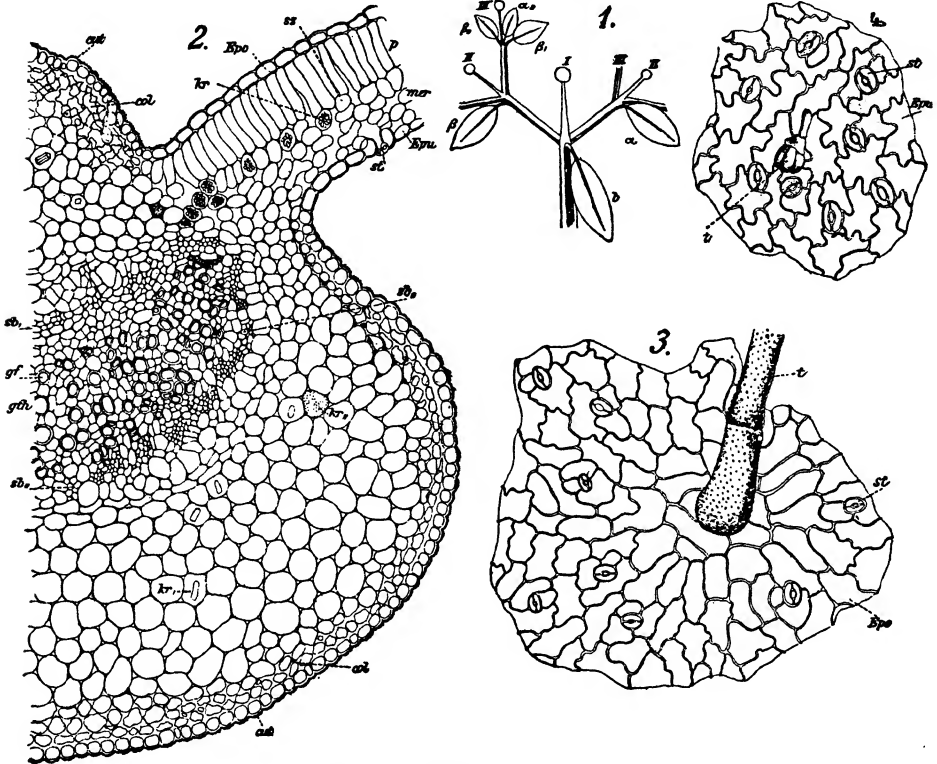


FIG. 400.—*Datura Stramonium*. 1. Diagram of structure of flowering branch. I, II and III, successive shoots. *b*, bract of I;  $\alpha$ ,  $\beta$ , bract of II;  $\alpha_1$ ,  $\beta_1$ , bracts of III; 2. Cross section through the midrib of the leaf with a portion of the interneural region (on right). *cut*, cuticle; *col*, collenchyma; *sb*, and *sb*<sub>1</sub>, upper and lower strands of sieve tissue and *gf*, tracheæ of bi-collateral bundles; *epo*, upper epidermis; *epu*, lower epidermis; *st*, stoma; *p*, palisade parenchyma; *mer*, spongy parenchyma; *kr*, rosette aggregate of calcium oxalate; *kr*<sub>1</sub>, prismatic crystal of calcium oxalate; *kr*<sub>2</sub>, microcrystals. 3. Upper epidermis of leaf in surface view showing *t*, non-glandular trichome; *st*, stoma and *epo*, epidermal cells. 4. Lower epidermis in surface view. (After Tschirch-Oesterle, *Atlas*.)

of the cells of which are filled with sphenoidal microcrystals; other although fewer cells of this region contain rosette aggregates or rod-like prisms of calcium oxalate.

2. *Lamina*, showing stomata in both epidermises, the lower epidermis possessing the greater number. The guard cells of the stomata are beaked. The mesophyll consists of a layer of elongated, narrow palisade cells with chloroplastid contents and a loose spongy parenchyma. The palisade zone is 1-layered

and occupies nearly one-half of the mesophyll. Directly beneath it is a layer which, while constituting the upper cells of the spongy parenchyma, is sometimes termed the *crystal layer*, since nearly every cell of this layer contains a rosette aggregate of calcium oxalate. Of the remainder of the spongy parenchyma cells, most possess chloroplastids, a few microcrystals and, occasional ones, rod-like prisms of calcium oxalate.

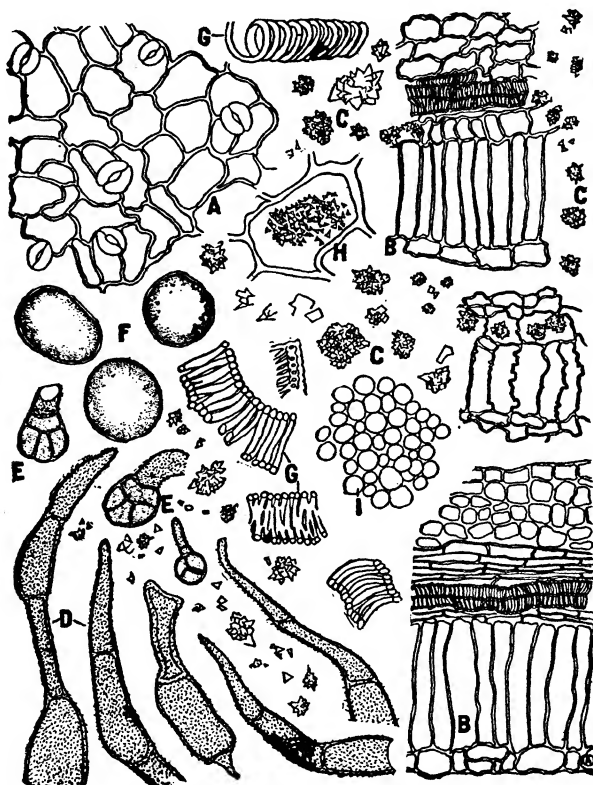


FIG. 401.—Powdered Stramonium,  $\times 183$ . A, Epidermis, surface view. B, Transverse section of leaf. C, Rosette aggregates of calcium oxalate. D, Non-glandular trichomes. E, Glandular trichomes. F, Pollen grains. G, Fragments of tracheae. H, Spongy parenchyma cell containing sphenoidal micro-crystals. I, Palisade parenchyma in surface view. (After Sayre.)

Surface sections of the upper epidermis, mounted in chloral solution exhibit mostly wavy-walled cells and elliptical stomata. The latter have, 3 (or seldom 4) neighboring cells, one of which is smaller than the others. Surface sections of the lower epidermis show the vertical cell walls to be more wavy than those of the upper epidermis. The stomata are more numerous and are surrounded by 3 or 4 neighboring cells, one of which is smaller than the rest. Both non-glandular and glandular hairs may be observed as outgrowths from both upper and lower epidermis. These are more abundant on younger than older leaves. The non-glandular hairs are uniseriate, usually 2 to 6 cells in length, never more

than 8 cells long. The basal cell averaged  $38\mu$  in width in 50 measured hairs. Some of the cells are more or less collapsed. The outer walls show numerous slight centrifugal projections. The glandular hairs have a 1- to 2-celled stalk and a 2- to 4-celled glandular head.

**Powdered Drug.**—Bright green, or light olive brown to dusky yellowish green; stomata elliptical with usually 3 but also 3 to 4 neighboring cells, one smaller than the others; calcium oxalate in rosette aggregates up to  $25\mu$  in diameter, and in prisms; many micro-crystals; non-glandular hairs few, 2- to 6-celled, the basal cell usually more than  $50\mu$  in length and from 35 to  $40\mu$  in diameter at the base, some of the cells more or less collapsed, the outer walls with many slight centrifugal projections; glandular hairs few with 1- to 2-celled, usually curved stalks and 2- to 4-celled glandular heads; stem fragments with epidermal hairs up to  $800\mu$  in length, occasional pericyclic fibers and annular or spiral, simple or bordered pored tracheæ associated with wood fibers or wood parenchyma; midrib fragments with long, narrow, unequally thickened collenchyma associated with parenchyma cells, some of the latter containing micro-crystals or prisms of calcium oxalate.

**Constituents.**—Up to 0.7 per cent. of the alkaloids *hyoscyamine*, *atropine*, *apoa tropine*, *belladonnine*, and *scopolamine*; resin, etc. *Daturine* is a mixture of hyoscyamine and atropine.

**Uses.**—Stramonium is chiefly used to relax the bronchial muscle in the bronchial spasms of asthma. It is also employed in postencephalitic Parkinsonism, paralysis agitans, and as an anodyne. Its properties are similar to belladonna and it has been used interchangeably with it.

**Average Dose.**—75 mg. ( $1\frac{1}{4}$  grains).

**Preparations.**—Stramonium Extract (pilular and powdered), U.S.P., 20 mg. ( $\frac{1}{3}$  grain); Stramonium Tincture, U.S.P., 0.75 cc. (12 minims); Stramonium Capsules, N.F., 75 mg. of Stramonium; Stramonium Fluidextract, N.F., 0.075 cc. ( $1\frac{1}{4}$  minims); Stramonium Ointment, N.F.

**Adulterants.**—(1) Leaves of *Xanthium italicum* Linné and other spp. of *Xanthium*, which are devoid of rosette crystals and of stomata on upper surface. They possess very short, non-glandular hairs, each with a broad basal cell containing a cystolith and a pointed, terminal cell that is frequently bent over. Some of the hairs contain rod-shaped crystals of calcium oxalate.

(2) Leaves of *Carthamus helenoides* Desfontaines which differ from Stramonium in possessing large rectilinear epidermal cells with striated cuticle and in the absence of rosette aggregates.

(3) Leaves of *Chenopodium hybridum* Linné.

**Allied Species.**—*Datura Metel* L. (*D. fastuosa* L.; *D. alba* Nees) is a woody annual, native to Asia and Africa and naturalized in the U.S. It is characterized by its ovate, entire, slightly toothed or wavy, glabrous leaves, unequal at the base, by the fruiting peduncle being curved to one side, sometimes cernuous, by its 5-lobed, white or colored corolla, the lobes of which are separated by acute sinuses. The fruit is a sub-globular, spiny capsule. The plant is glabrous or nearly so.

*Datura meteloides* Dunal is a perennial, woody herb, cultivated as an annual in the north, glaucescent and puberulent. Its leaves are inequilaterally ovate, nearly entire, acuminate. Its fragrant flowers are characterized by a tubular, 5-toothed calyx, a tubular-infundibuliform corolla which is white and usually tinged with violet or pale lavender, with a 5-toothed limb. The fruit is a nodding, sub-globular capsule. Native to southern United States, Mexico and northern South America.

*Datura innoxia* Mill., the Downy Thornapple, a woody herb native to Mexico, the West Indies and South America and cultivated in the United States, differs from the preceding species chiefly by the soft pubescence on its leaves and young branches, its 10-angled corolla, and its fruit whose pericarp has weak spines and contains brown seeds. All three of these species possess *scopolamine* as the dominant alkaloid and have been used as sources of scopolamine.

#### HYOSCYAMUS U.S.P. (HYOSCYAMUS)

**Synonyms.**—*Henbane*, *Hyoscyami folium*, Black Henbane, Hog's Bean, Stinking Nightshade; *Ger.* Bilsenkrautblätter; *Fr.* Jusquiame.

**Botanical Origin.**—*Hyoscyamus niger* Linné.

**Part Used.**—The dried leaf with or without the tops.

**Standard of Assay.**—Not less than 0.040 per cent. of the alkaloids of *Hyoscyamus*.

**Limit of Impurities.**—25 per cent. of its stems, none of which is more than 7 mm. in thickness. Not more than 12 per cent. of acid-insoluble ash.

**Habitat.**—Europe and Asia.

**Plant.**—A biennial or annual, fetid, narcotic herb growing to the height of from 0.6 to 1.4 m. Its underground portion consists of a large, brown, fleshy, branching root, somewhat resembling parsley root, for which it has been mistaken with disastrous results. Its aerial portions in the first year biennial variety consists of a very short stem bearing a rosette of petiolate, hairy ovate-lanceolate leaves near the ground. In the second year biennial it consists of a pubescent, branching stem bearing alternate, triangular-ovate or ovate-oblong, sessile, clasping, grayish-green leaves having a sinuate-dentate margin and acute apex. The flowers usually appear on the biennial variety in May and June and on the annual variety in July and August, on one sided leafy spikes. Each shows a green, urn-shaped, 5-toothed, hairy calyx, a 5-lobed, dull yellow, campanulate corolla, the lobes being unequal, the veins purple and reticulate, 5 stamens with purple anthers and a bicarpellary pistil with purple style. The fruit is a 2-celled pyxis, enclosed in a persistent calyx.

**Production and Commerce.**—*Hyoscyamus* grows wild in waste places of lower Canada, north central United States, Europe and Asia. It is also cultivated from seeds. Good results have been obtained by sowing the seed in small pots under glass in December and January, transplanting to 3-inch pots in March and transferring to the field in early May. The plants are set out about 18 inches apart in rows at least 30 inches apart. The soil should be deep loam, kept moist, well drained and limed. The soil should be kept free of weeds

and loosened up by cultivation from time to time. Like other Solanaceous plants, *Hyoscyamus* is susceptible to attacks of the potato beetle, which has destroyed large crops. The writer has found that occasional spraying with a solution of rotenone is advantageous in retarding the depredations of this pest. Pyrethrum or Derris dusts are also effective insecticides. The leaves and flowering tops should be gathered while the plants are in full flower. They should be dried in the shade. Care should be exercised in harvesting the drug owing to its sticky nature and the ready adherence of soil to it. Some of the drug used in this country is procured from Montana where the plant has become naturalized, and from drug farms, the largest of which is in Michigan. Considerable, however, is imported from Europe mainly from Russia and Belgium. During 1947, 505,890 lbs. of Henbane were imported into this country from Belgium, United Kingdom, Hungary, Russia, Egypt and India. Large importations of Egyptian *Hyoscyamus* have also arrived from Egypt to be used in the manufacture of *Hyoscyamus* alkaloids.

Just before sowing *Hyoscyamus* seeds, it is advisable to give them the sulfuric acid treatment for 75 seconds, followed by immediate and frequent washings in cold water to remove acid.

**Description.**—The drug occurs as wrinkled, matted, and broken leaves intermixed with numerous stems and flowering and fruiting tops. Leaves when entire attaining a length of 26 cm., a breadth of 10 cm., ovate or ovate-oblong, inequilateral, the lower petiolate, the upper sessile, summits acute, margins irregularly dentate to pinnatifid with acute triangular lobes, glandular-hairy, especially on lower surface; upper surface dark green, lower surface light gray-green; flowers nearly sessile with a 5-toothed urn-shaped, hairy calyx and a yellow campanulate corolla which is slightly zygomorphic and possesses purplish veins; fruit a 2-chambered urn-shaped pyxis, enclosed in a large urn-shaped, 5-toothed calyx; odor heavy and distinct; taste somewhat bitter and acrid. The stems are up to 20 cm. in length, from 2 to 7 cm. in diameter, cylindrical or somewhat compressed, grayish green, hollow, longitudinally wrinkled and hairy.

Seeds dark gray, subreniform, campylotropous, with a closely verrucose spermoderm and a kernel with curved embryo embedded in endosperm.

**Histology.**—Like *Belladonna* and *Stramonium*, the leaf of *Hyoscyamus* exhibits bifacial structure. Both epidermises of the **leaf blade** possess cells with a smooth cuticle and, as viewed in surface sections, wavy, vertical walls, stomatal apparatuses of the solanaceous type, and uniseriate non-glandular hairs and glandular hairs. The mesophyll is differentiated into a layer of palisade parenchyma and a broad zone of spongy parenchyma, the latter with large intercellular air-spaces. Some of the parenchyma cells contain single prisms, twin crystals or rosette aggregates of calcium oxalate. The hairs are particularly abundant on the epidermis of the midrib and veins and are up to 300 $\mu$  in length.

The **midrib** region, as viewed in transverse section, shows a central, more or less crescent-shaped meristele of bicollateral bundles surrounded by parenchyma containing sphenoidal micro-crystals and prisms, the parenchyma being covered



FIG. 402.—*Hyoscyamus niger*. 1. A flowering branch. 2. The same, in fruit below. 3. A radical leaf. 4. Corolla cut open. 5. Vertical section of calyx and ovary. 6. Transverse section of ovary. 7. Ripe fruiting calyx. 8. Pyxis. 9. Vertical section of pyxis. 10. Seed. 11. Longitudinal section of seed. (After Bentley and Trimen.)

on both sides by a hairy epidermis. In leaves of cultivated *Hyoscyamus* the glandular type of hair appears to predominate.

The stem exhibits an epidermis with hairs similar to those of the leaf, a cortex of parenchyma containing micro-crystals, a circle of bicollateral bundles separated by narrow medullary rays and a central pith of crystal-bearing parenchyma which is hollow in older parts. The xylem wedges of the bundles exhibit pitted, reticulate, bordered-pored and spiral tracheæ.

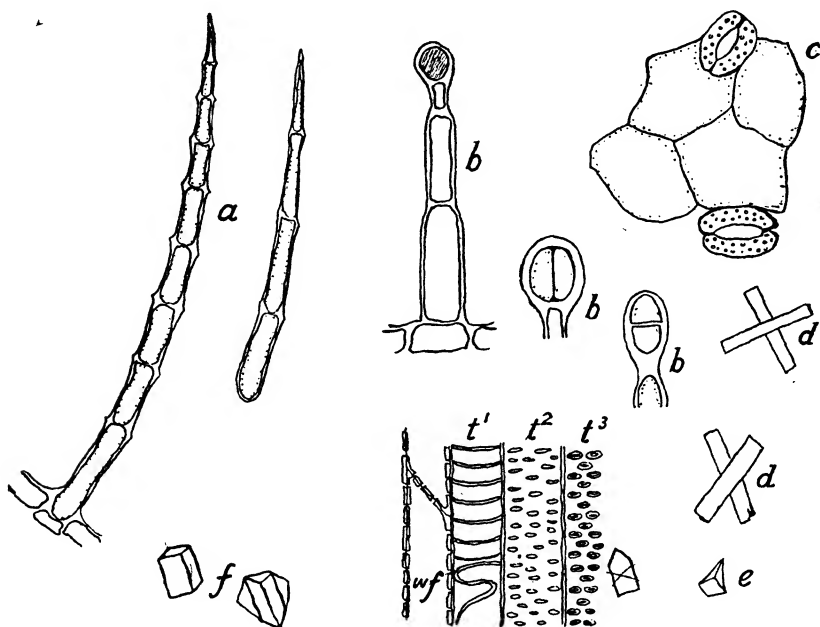


FIG. 403.—*Hyoscyamus*. Histological elements. Non-glandular hairs (a); types of glandular hairs (b); surface view of portion of lower epidermis (c), showing epidermal cells and stomata; wood fiber (wf); spiral trachea ( $t^1$ ); porous trachea ( $t^2$ ); trachea with bordered pores ( $t^3$ ); twin crystals of calcium oxalate (d); micro-crystal (e); monoclinic prism and twin crystal (f).

**Powdered Drug.**—Grayish-green to dark green; numerous microcrystals; calcium oxalate in 4- to 6-sided prisms, twin crystals up to  $25\mu$  long, occasionally in rosette aggregates from 10 to  $25\mu$  in diameter; non-glandular hairs from 1-10 cells in length, often broken; glandular hairs with a 1- to 4-celled stalk and a unicellular or multicellular head; fragments of epidermis with broadly elliptical stomata with 3 or 4 neighboring cells, one of which is smaller than the others; fragments of tracheæ with simple or bordered pores and reticulate or spiral thickenings, often associated with sclerenchyma fibers; sclerenchyma fibers up to 1 mm. in length and  $30\mu$  in width, some with wavy walls and variously forked ends; pollen grains nearly smooth, subspherical, the exine with scattered pits and with 3 radiating furrows, having a pore in the middle of each furrow, when dry or in alcohol distinctly elliptical and approximately 35 by  $50\mu$ , but in water spherical and about  $40\mu$  in diameter.



**Constituents.**—*Hyoscyamine*, a crystalline alkaloid whose solution is lævorotatory, *scopolamine* (*hyoscine*), an amorphous alkaloid; *hyoscyopicrin*, a glycoside; volatile oil, etc.

**Scopolamine Hydrobromide U.S.P.** (Hyoscine Hydrobromide) is the hydrobromide of lævorotatory Scopolamine obtained from plants of the *Solanaceæ*.

*Scopolamine*, also called *hyoscine*,  $C_{17}H_{21}O_2N$ , is a lævorotatory syrup soluble in ordinary solvents and forming salts with acids, one of which, the official hydrobromide, crystallizes in colorless rhombic plates and is readily soluble in

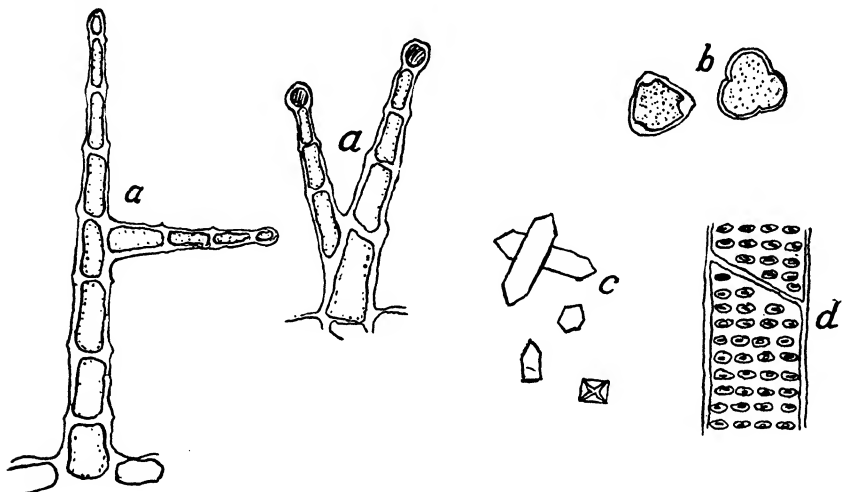


FIG. 404.—*Hyoscyamus muticus*. Diagnostic histological elements. Branched hairs (a); pollen grains (b); types of calcium oxalate crystals (c); portions of two adjacent tracheæ with bordered pores (d).

water and alcohol. The best sources of hyoscine are *Datura metel*, *D. innoxia* and *Scopolia*.

**Uses.**—*Hyoscyamus* is used to check vesical spasm in urinary incontinence, as a sedative in cystitis and gonorrhœa and is also combined with purgatives to obviate their griping action. The alkaloid scopolamine is a sedative to the central nervous system and is employed in the form of its hydrobromide as a sedative in acute maniacal excitement, delirium tremens and tetanus, in relieving the tremor of paralysis agitans, in Parkinsonism, to enhance the hypnotic effect of morphine preliminary to general anesthesia, in the treatment of the alcohol and morphine habits, in sea- and air-sickness, and as an anaphrodisiac. In ophthalmology it is used as a mydriatic and cycloplegic.

**Average Dose.**—0.2 Gm. (3 grains); of Scopolamine Hydrobromide, U.S.P., 0.5 mg. ( $\frac{1}{20}$  grain).

**Preparations.**—*Hyoscyamus* Extract, N.F., 50 mg. ( $\frac{3}{4}$  gr.); *Hyoscyamus* Tincture, 2 cc. (30 minims); *Hyoscyamus* Fluidextract, N.F., 0.2 cc. (3 minims).

**Adulterants.**—(1) Egyptian or Cyprus Henbane. The leaves and tops of *Hyoscyamus muticus* Linné from Egypt have frequently been admixed with the

imported drug. This spurious article may be readily detected by peculiar branching non-glandular hairs which occur both on the leaves and stems. It has been used by some manufacturers as a source of hyoscyamine, which is present in amounts varying from 0.2 to 1.0 per cent. Samples offered to purchasers in this country have consisted chiefly of thick, broken, yellowish stems, few leaf fragments and cylindrical-shaped pyxes. (See Fig. 404.)

(2) Stramonium has been found admixed with some imported lots of Hyoscyamus.

DISTINCTIONS BETWEEN BELLADONNA, STRAMONIUM AND HYOSCYAMUS

	Belladonna	Stramonium	Hyoscyamus
Botanical Origin	<i>Atropa Belladonna</i>	<i>Datura Stramonium</i> including <i>D. tatula</i>	<i>Hyoscyamus niger</i>
Plant	Perennial herb	Annual herb	Annual and biennial herbs
Leaf blade	Broadly oval, the margin entire; apex acute to acuminate	Inequilaterally ovate to triangular ovate; margin sinuate-dentate apex acuminate	Inequilaterally ovate-oblong to ovate-lanceolate; margin irregularly dentate to pinnatifid; apex acute
Corolla	Yellowish purple to livid purple, tubular-campanulate	White to purple, plicate-infundibuliform	Yellow with a network of purple veins, campanulate
Fruit	Subglobose 2-celled berry	Prickly 4-valved capsule	Urn-shaped pyxis, 2-celled
Cuticle of leaf blade	Striated	Smooth	Smooth
Crystals	Micro-crystals Rosette aggregates in fruits	Rosette aggregates, monoclinic prisms and micro-crystals	4- to 6-sided prisms, twin prisms, rosette aggregates, micro-crystals
Non-glandular hairs	Uniseriate, 2- to 6-celled Slender branched hairs on petiole	Uniseriate, with thin warty walls, mostly up to 3-celled, occasionally up to 6-celled	Uniseriate, up to 10-celled
Glandular hairs	Stalk of 1- to 4-cells; head of 1- to many-cells	Stalk of 1- to 2-cells; head of 2- to 4-cells	Stalk of 1- to 2-cells; head of 2- to 4-cells; in cultivated plants both stalk and head with increased number of cells

SOLANUM (SOLANUM)

**Synonyms.**—Horse Nettle Berries; Apple of Sodom.

**Botanical Origin.**—*Solanum carolinense* Linné.

**Part Used.**—The air-dried ripe fruit.

**Purity Rubric.**—Not more than 5 per cent. of immature fruit and not more than 2 per cent. of foreign organic matter.

**Habitat.**—Eastern United States in fields and waste places.

**Plant.**—A rough, pubescent, perennial herb with prickly stem, alternate ovate to oblong, sinuate-dentate or sinuate, pinnately-divided leaves and racemes of violet, rarely white colored flowers. The fruit is a yellowish, globular, 2-celled berry.

**Production and Commerce.**—Horse Nettle grows wild in dry fields from southern Canada to Illinois and south to the Gulf of Mexico. The fruits are collected when ripe during the summer and dried in the sun. The commercial supply is obtained almost entirely from plants growing wild in this country.

**Description.**—Berries globose, somewhat shriveled and wrinkled, from 0.8 to 2 cm. in diameter, orange-yellow, glabrous, fleshy, 2-celled, many-seeded, calyx and pedicel usually persistent; calyx pubescent, 5-lobed, the lobes enclosing half or more of the berry; seeds flat, yellow, orbicular: odor pepper-like; taste bitter and acrid.

**Constituents.**—*Solanine* (alkaloid), fat, volatile oil, resin, etc.

**Use.**—Horse Nettle Berries are employed usually in the form of fluidextract as a sedative in the treatment of epilepsy.

**Average Dose.**—4 Gm. (60 grains).

**Preparation.**—Fluidextractum Solani (unof.) 4 cc.

#### CAPSICUM N.F. (CAPSICUM)

**Synonyms.**—Cayenne Pepper, African Cayenne, Red Pepper, African Chillies, Zanzibar-, Mombasa-, Nyasaland- or Sierra Leone Pepper; Tabasco Pepper; Louisiana Long Pepper; Louisiana Sport Pepper; *Fr.* Capsique; *Ger.* Schlotenpfeffer.

**Botanical Origin.**—*Capsicum frutescens* Linné (African Chillies), *Capsicum annum* Linné var. *conoides* Irish (Tabasco Pepper), *Capsicum annum* Linné var. *longum* Sendt (Louisiana Long Pepper) or a hybrid between the Honka variety of Japanese Capsicum and the Old Louisiana Sport Capsicum (Louisiana Sport Pepper).

**Part Used.**—The dried ripe fruit.

**Standard of Assay.**—Not less than 12 per cent. of non-volatile ether-soluble extractive.

**Purity Rubric.**—Capsicum contains not more than 3 per cent. of its stems and calyces, and not more than 1 per cent. of other foreign organic matter; it yields not more than 1.25 per cent. of acid-insoluble ash.

**Habitat.**—Tropical America.

**Plants.**—*Capsicum frutescens* is a shrubby perennial with angled stem and branches, broadly ovate-acuminate leaves, 7.5 to 15 cm. in length, axillary greenish-white or white flowers with peduncles 2.5 to 5 cm. in length, the calyx cup-shaped, embracing base of fruit, the corolla rotate and often with ocherous markings in the throat. The fruit is a pungent, oblong-conical berry, up to 30 mm. in length. The other sources are annuals.

**Production and Commerce.**—The plants are cultivated in United States, Mexico, India, Japan, and British East Africa. The fruits are collected when

fully mature, deprived of their calyxes and carefully dried. Most of the drug used in this country has been imported from Zanzibar, Mombasa, Nyasaland and Sierra Leone but more recent supplies have also been obtained from plants cultivated in Louisiana. During 1947, 2,025,335 lbs. of unground capsicum were imported into this country from Nigeria, Gold Coast, British East Africa, Belgian Congo, Mexico, Chile, Haiti and Italy. The label must specify which commercial variety is contained within the package.

**Description.**—Oblong-conical, often curved (Louisiana Long Pepper), from 10 to 25 mm. in length and from 4 to 8 mm. in diameter (African Chillies) or up to 15 cm. in length and 2.5 cm. in diameter (Louisiana Long Pepper) or up to 5.5 cm. in length and up to 13 mm. in diameter (Louisiana Sport Pepper) or up to 4 cm. in length and up to 9 mm. in diameter (Tabasco Pepper), 2–3 locular, the dissepiments united to a conical, central placenta at the base of

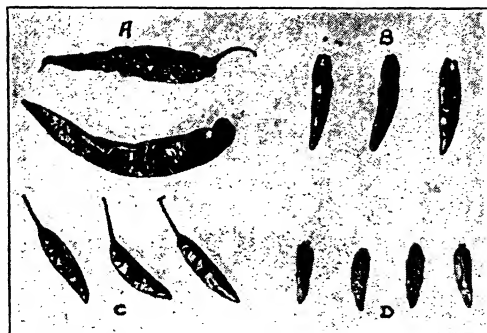


FIG. 405.—Four kinds of Louisiana grown pungent Capsicums  $\times \frac{1}{4}$ . A, Louisiana Long Pepper. B, Louisiana Sport Pepper. C, African Chillies  $\times$  Japanese Capsicum (hybrid). D, Tabasco Pepper. (After H. W. Youngken, *Jour. A.Ph.A.* (1938), 324.)

the fruit; pericarp thin and membranous, its outer surface dark reddish-brown to dusky yellowish-orange, glabrous, shrivelled, its inner surface striate with 2 to 3 distinct longitudinal ridges representing parietal placenta; seeds light brown to weak yellowish-orange, suborbicular or irregular, flattened, from 2 to 4 mm. in diameter, with a thickened edge and prominent, pointed micropyle; odor characteristic, sternutatory; taste intensely pungent, that of the dissepiments more pungent than the pericarp. The calyx, when present, is moderate-brown to dusky yellowish-orange, gamosepalous, inferior, 5-toothed and sometimes attached to a long peduncle.

**Histology.**—Transverse sections of the pericarp of African Cayenne, mounted in chloral hydrate solution, show the following characteristics (see Fig. 407):

1. *Epicarp*, an outer layer of mostly rectangular to quadrangular epidermal cells up to  $80\mu$  in length and up to  $20\mu$  deep, whose outer walls and greater portion of the radial walls are cutinized. The radial walls are somewhat wavy.

2. *Mesocarp*, composed of several layers of parenchyma cells, many containing yellowish-red oil globules and chromoplastids, others micro-crystals of

calcium oxalate. Coursing through this region are a few bicollateral bundles with spiral and pitted tracheæ. The innermost layer of cells of the mesophyll consists of very large cells (giant cells).

3. *Endocarp*, comprising a single row of cells, some of which are sclerenchymatous, others with thin, cellulose walls. The former occur directly beneath the lumina of the giant cells and have thick, lignified, porous walls.

Surface sections of the *epicarp* exhibit rows of quadrangular or rectangular, parallel, mostly 4-sided, straight-walled epidermal cells, having a finely striated cuticle.

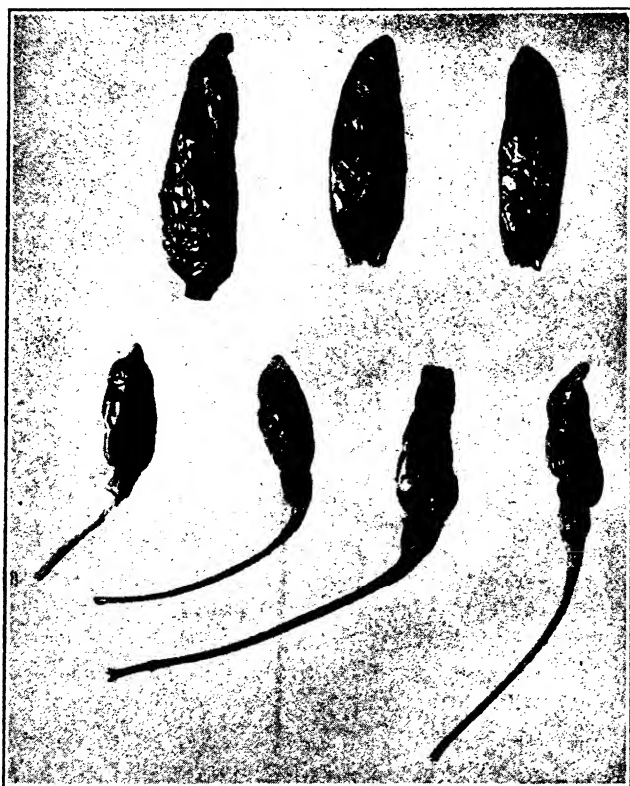


FIG. 406.—Mombasa Capsicum U.S.P., the fruit of *Capsicum frutescens*.  $\times 2$ .

Surface sections of the *endocarp* exhibit oval- to elliptical-shaped groups of stone cells separated by narrow zones of thin-walled cells containing chromoplastids. The stone cells are more or less elongated, moderately thickened, porous and slightly lignified and have beaded, wavy, vertical walls.

Transverse sections of the *dissepiment* show a central zone of tangentially-elongated, more or less collapsed cells, some of which contain micro-crystals. Fibrovascular tissue courses through this region. Flanking this zone on either side is an epidermis of radially elongated cells containing capsaicin, a pungent principle. The outer walls of the epidermal cells are cutinized. Here and there,

where the cuticle has been puckered up, it is possible to see oily droplets of *capsaicin*.

Transverse sections of the seeds exhibit the following peculiarities:

1. *Spermoderm*, (a) Outer epidermis showing large, more or less radially elongated, stone cells with irregularly thickened radial and inner walls. The radial walls of each of these show a thickening of lignin which gradually increases toward the inner wall. The inner wall is extremely thickened in the angles,

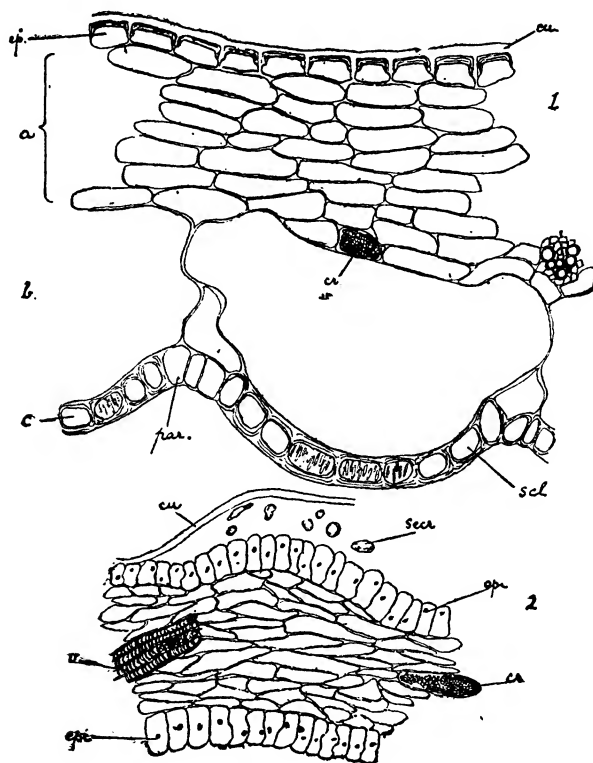


FIG 407.—Capsicum. 1, transverse section of pericarp; a, mesocarp parenchyma; b, large-celled layer of same; c, inner epidermis or endocarp; cr, micro-crystals; par, parenchymatous cells and scl, sclerenchymatous cells of endocarp. 2, transverse section of dissepiment; cr, microcrystals; cu, cuticle, raised by the secretion, secr.; epi., epidermis; v, vascular bundle,  $\times 170$ . (From Greenish's "Microscopical Examination of Foods and Drugs" after Wallis, J. & A. Churchill.)

less so in the center. The epidermal stone cells along the edge of the seed possess much thicker walls than those on the flat surfaces. (b) A narrow zone of collapsed parenchyma. (c) Inner epidermis of a row of tangentially elongated epidermal cells.

2. *Endosperm*, a broad zone of reserve parenchyma, composed of more or less thick-walled, polygonal cells containing aleurone grains.

3. *Embryo*, appearing in this kind of section as more or less circular areas of cells lined with epidermis and embedded in the endosperm. The cotyledons

may be distinguished from the hypocotyl by appearing as 2 plano-convex masses with plane faces opposite, in the same circular area.

Surface sections of the *outer epidermis* of the seed coat mounted in chloral show strongly lignified, yellowish stone cells with sinuous and porous, vertical

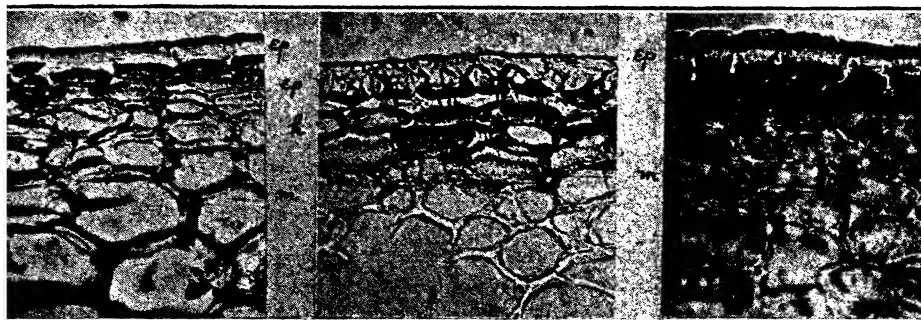


FIG. 408.—Transverse sections through the outer region of the pericarps of three Louisiana Capsicums.  $\times 300$ . L, Capsicum, La. Long; S, Capsicum, La. Sport; T, Tabasco. *ep*, epidermis; *h*, hypodermis; *m*, mesocarp. (After H. W. Youngken, *Jour. A.Ph.A.* (1938), 325.)

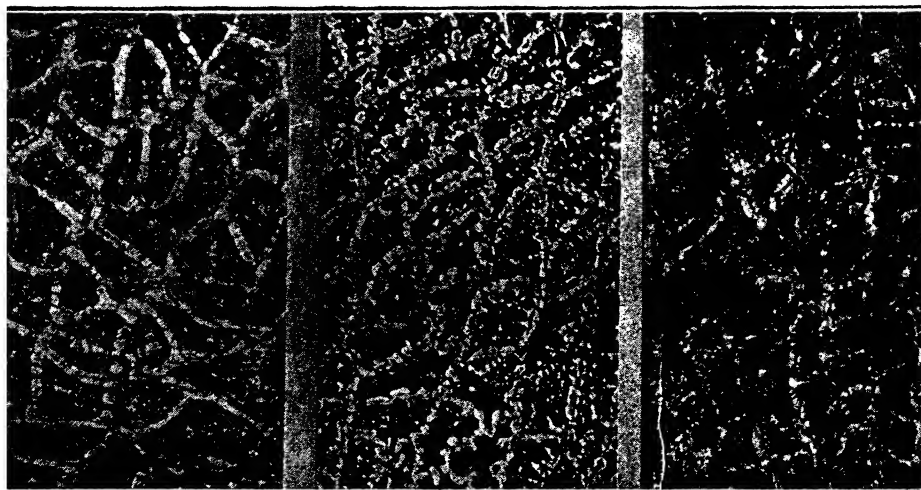


FIG. 409.—Surface sections of the epicarps of three Louisiana grown Capsicums.  $\times 200$ . L, La. Long; S, La. Sport; T, Tabasco. (After H. W. Youngken, *Jour. A.Ph.A.* 27 (1938), 326.)

walls. Longitudinal sections cut parallel to the flat surfaces show that the embryo is curved.

Sections (both surface and transverse) of the calyx show stomata only on the lower epidermis. Each of these is surrounded by 3 or 4 neighboring cells, one of which is smaller than the others. Numerous glandular hairs occur on the

upper epidermis. These possess 1- to 3-celled stalks and pluricellular heads. The head of each of these contains a yellow secretion. The mesophyll is composed of leaf parenchyma, some of the cells of which are filled with micro-crystals.

Sections of the peduncle exhibit a pericyclic region containing sclerenchyma fibers.

The chief histological features characterizing the various official capsicums may be found in the epicarp and tissue immediately subjacent thereto.

**African Chillies** possesses an epicarp with straight-walled, rectangular or nearly rectangular cells arranged in more or less parallel, regular rows (as observed in surface sections) with thickened, cuticularized outer and radial (vertical) walls which are not beaded. The cuticle is striated. The cells are  $25\mu$  to  $80\mu$  in length and up to  $20\mu$  deep. Its hypodermis is composed of thin-walled, parenchyma cells with cellulose walls.

**Tabasco Pepper** exhibits an epicarp of irregularly rectangular, quadrangular, polygonal to triangular cells with highly cuticularized outer and radial walls, the latter frequently beaded. These cells are up to  $76\mu$  in length and up to  $30.5\mu$  deep. Its hypodermis is composed of somewhat collenchymatous cells.

**Louisiana Long Pepper** has an epicarp of polygonal to quadrangular and triangular cells with cuticularized outer, radial and portions of inner walls, the radial walls prominently beaded. These cells are up to  $125\mu$  in length and up to  $38\mu$  deep. Its hypodermis is composed of tangentially-elongated collenchymatous cells.

**Louisiana Sport Pepper** possesses an epicarp of polygonal, quadrangular, rectangular and triangular cells with a striated cuticle and with cuticularized outer and radial walls. These cells are up to  $76\mu$  in length and up to  $38\mu$  deep. Its hypodermis consists of 1, 2 or 3 rows of hypodermal cells with cuticularized walls.

**Powdered Capsicum.**—Dark orange, dark reddish-orange to strong yellowish-brown; numerous fragments of thin-walled parenchyma containing oil globules and orange, red or yellow chromoplastids; fragments of epicarp with either striated, rectangular cells arranged in parallel rows (African Chillies), or with polygonal, triangular or irregular cells with or without beaded walls; endocarp stone cells with slightly wavy, beaded, lignified walls and broad lumina; numerous fragments of spermoderm composed of stone cells, showing in surface view, deeply sinuate, greatly thickened and lignified vertical walls containing numerous pore canals and, in vertical sections, beaker-shaped cells whose radial and inner walls are more thickened than the outer walls; few fibers; fragments of small-celled parenchyma of endosperm and embryo, most of the cells of which possess fixed oil aleurone grains; numerous globules of yellowish-red oil; a few spiral and pitted tracheæ; cells containing micro-crystals; occasionally tissues of the calyx and peduncle and a few more or less spheroidal starch grains from unripe fruits. (See Fig. 410.)

**Constituents.**—The pungent principle, *capsaicin* (capsacutin); a volatile alkaloid, vitamin C, resin, fixed oil, etc.



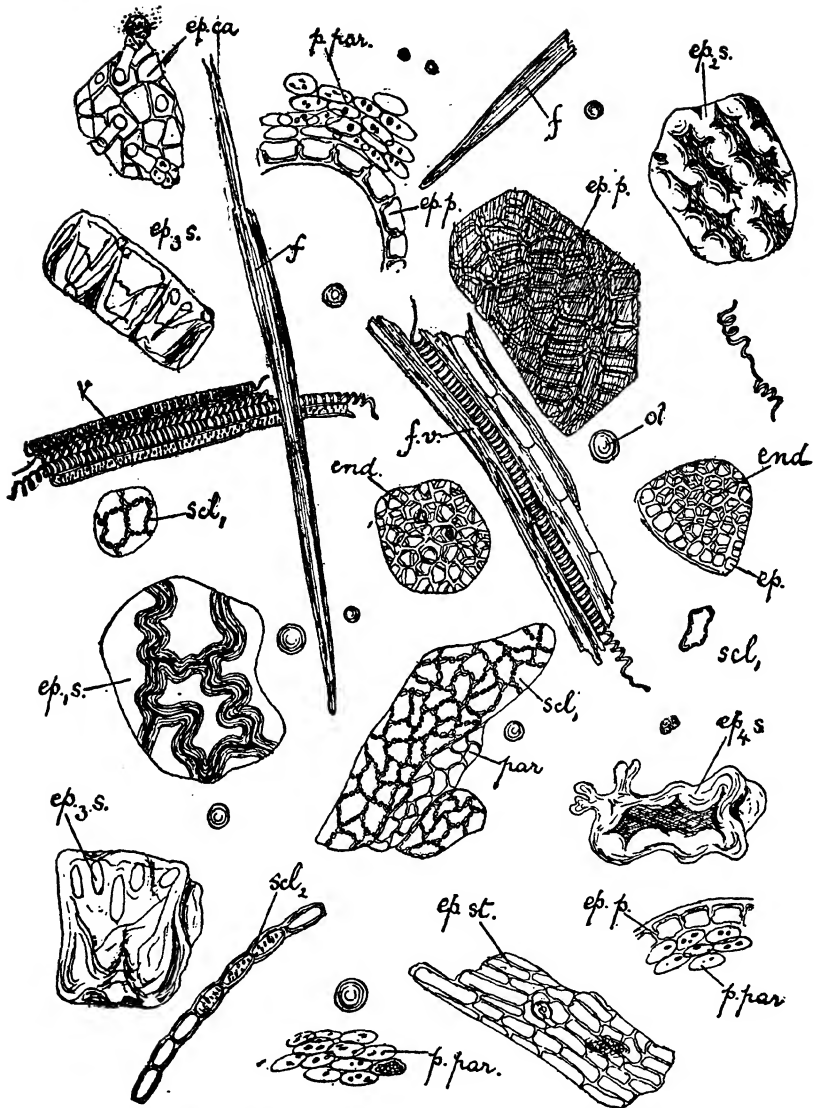


FIG. 410.—Powdered Capsicum. *end.*, endosperm; *ep.*, epidermis of same; *ep. ca.*, upper epidermis of calyx; *ep. p.*, epicarp; *ep. 1s.*, epidermis from flat surface of seed; *ep<sub>2</sub>s.*, epidermis from edge of seed; *ep<sub>3</sub>s.*, epidermis of seed showing one stone cell, side view; *ep. 1s.*, isolated epidermal cell of seed coat; *ep. st.*, epidermis of stalk; *f.*, sclerenchyma fibers; *f. v.*, fibrovascular bundle; *ol.*, oil; *par.*, parenchyma of endocarp; *p. par.*, parenchyma of mesocarp; *scl<sub>1</sub>*, sclerenchyma of endocarp, seen from above; *scl<sub>2</sub>*, the same, side view. X 108. (From Greenish's "Microscopical Examination of Foods & Drugs" after Wallis, J. & A. Churchill.)

**Uses.**—In medicine as a stimulant, counterirritant and stomachic; in the culinary art for the flavoring of meat and fish dishes and sauces, as a constituent of some pickling spice formulæ and curry powder.

**Average Dose.**—60 mg. (1 grain).

**Preparations.**—Tinctura Capsici N.F., 0.5 cc. (8 minims); Unguentum Capsici, N.F.; Tinctura Capsici et Myrrhæ, N.F., 2 cc. (30 minims); Oleoresina Capsici, N.F., 15 mg. ( $\frac{1}{4}$  gr.).

**Adulterants.**—Japanese-Capsicum or Chillies is conical, bright red, 15 to 45 mm. in length and usually free of peduncle and calyx. The fruits differ further from African Chillies by possessing an epicarp whose cuticle is devoid of striations and in having a single layer of cuticularized, thick-walled and pitted hypodermal cells. Japanese capsicum has been substituted for the whole drug.

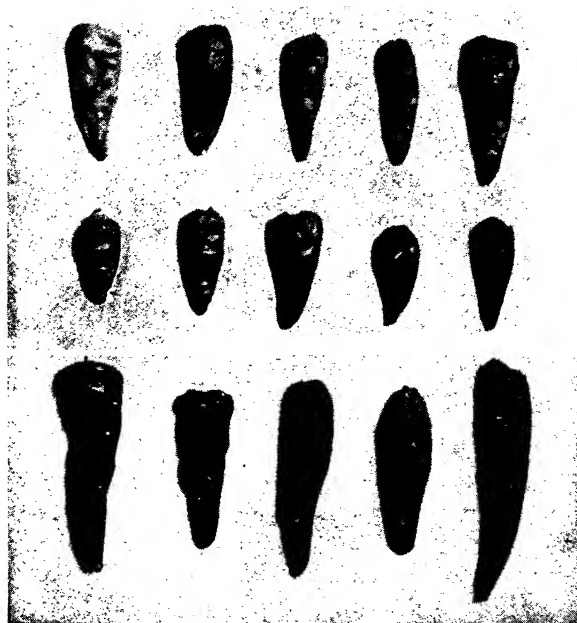


FIG. 411.—Japanese Capsicum  $\times \frac{3}{5}$ .

**Allied Products.**—Paprika or Garden Pepper represents the dried fruit of one or more varieties of *Capsicum annuum* Linné, an annual herb indigenous to tropical America and widely cultivated. It contains *ascorbic acid*.

Paprikas vary in shape, size, color, aroma and taste depending upon the botanical variety, conditions during production and processing, etc. A paprika of good quality should possess a bright dark red to bright brick red color, a slight agreeable odor and a slightly sweet and mild pungent taste.

Paprikas are produced for the American market in the United States, Portugal, Chile, Argentina, Spain and Hungary. The ground spice is used as a garnish and flavor for many culinary dishes, as an ingredient in a number of ground spice formulæ, and in the manufacture of chili sauce, tomato catsup, fancy meats, etc. Whole paprikas are employed for pickling as well as for condiment purposes.

**Hungarian Paprika** is a large, bright red to brownish-red, conical, tetragonal paprika, up to about 10 cm. in length and up to about 7 cm. in diameter which is grown in Hungary and extensively used as a spice.

**Rosenpaprika** is Hungarian Paprika prepared by grinding selected fruits from which placenta, stalks and stems have been removed.

**Königspaprika** is Hungarian Paprika prepared by grinding entire fruits including seeds and peduncles.

**Spanish Paprika** also known as **Pimiento** and **Pimenton** is extensively used in the stuffing of olives, the fleshy, sweet, pericarp being used for this purpose. The whole dried fruits are also employed as a spice. They are subglobular, bright scarlet red, up to 4 cm. in length and 6 cm. in diameter and devoid of pungency.

All of the paprikas are characterized by an epicarp which in surface section exhibits irregular, polygonal cells with numerous pits and beaded walls, and by several layers of collenchyma cells with rounded outline directly beneath the epicarp.

During 1945, 5,253,178 pounds of paprika were imported into the U.S.A. from Spain, Portugal and Chile.

#### SCROPHULARIACEÆ (FIGWORT FAMILY)

Herbs (*Linaria*, *Verbascum*, *Gerardia*, *Digitalis*, etc.), shrubs (shrubby *Veronicas*, etc.), rarely trees (*Paulownia tomentosa*). Stem, branches and leaves usually green and independently vegetating, but in *Pedicularis*, *Gerardia*, *Euphrasia*, *Buchnera*, *Rhinanthus*, etc., the stem, leaves, and branches are condensed from the development of a parasitic root habit. Stems cylindrical to frequently quadrangular, especially when leaves are opposite. Leaves alternate to opposite and decussate, simple, exstipulate, often hairy, but becoming by drought or parasiticism reduced to scales or almost absorbed. Inflorescence a raceme of cymes (*Paulownia*) or a simple raceme (*Foxglove*, *Linaria*, etc.) or spike (*Verbascum Thapsus*) or, if leaves are opposite, often a whorl of axillary flowers or solitary axillary flowers. Flowers rarely regular, mostly irregular; calyx of five sepals condensed in *Veronica* to four, through absorption of one sepal by fusion of two sepals; corolla of five to four petals, deeply synpetalous, varying from rotate (*Verbascum Blattaria*, etc.) to irregular tubular to elongate, irregular bilabiate to funnel-shaped. In color, corolla varies from greenish to greenish-yellow or white (*Scrophularia*) to pure white or from red to purple to blue (*Veronica*). Stamens five, fertile, equal in length in a few *Verbascum* species or unequal in other *Verbascum* species to stamens four with a long sterile staminode (*Pentstemon*) to four didynamous stamens with a short petaloid staminode (*Scrophularia*) to four didynamous stamens with a minute often nectariferous staminode (*Linaria*), to frequently four didynamous stamens only, the two lateral or two anterior stamens stronger and longer (*Antirrhinum*) to two perfect stamens and two minute staminodes (*Calceolaria*) to two stamens alone developed (*Veronica*). Pistil bicarpellate; ovary two-celled with central placentation; style terminal with bilobed stigma; ovules numerous, small.

Fruit a two-celled and usually many-seeded capsule. Seeds richly albuminous, anatropous or amphitropous.

Among the outstanding histological features of this family are the following: Stomata surrounded by three or more epidermal cells, tracheæ with simple pores, bearing bordered pits where in contact with parenchyma; the absence of intraxylary phloem; the presence of simple, unicellular or uniseriate trichomes and in *Verbascum* spp. of branched multicellular trichomes; the presence of glandular hairs, the head of which is unicellular or of 2 or more cells divided



FIG. 412.—*Digitalis purpurea*. First year's growth. (Photograph by Hogstad.)

by vertical walls; calcium oxalate occurs in some of the genera usually in small, prismatic acicular or octahedral crystals; carotin and protein crystals frequent in the mesophyll.

#### DIGITALIS U.S.P. (DIGITALIS)

**Synonyms.**—*Foxglove*, *Digitalis folium* P.I., Folk's, Fairy's, or Ladies' Glove, Dead Men's Bells, Purple Foxglove; *Ger.* Fingerhutblätter; *Fr.* Doigtier, Feuilles de digitale pourprée.

**History.**—*Digitalis* was used in the domestic medicine of Great Britain as far back as the tenth century, but was not introduced into regular medical practice until 1775, when Dr. William Withering of Birmingham, England, obtained knowledge of its value in dropsy from an old lady of Shropshire. Little was known concerning its active principles until Nativelle, a Frenchman, discovered the potent glycoside digitoxin in 1871.

**Botanical Origin.**—*Digitalis purpurea* Linné.

**Part Used.**—The dried leaf.

**Limit of Impurities.**—6 per cent. of moisture, 2 per cent. of stems, flowers, browned leaves or other foreign organic matter; it yields not more than 5 per cent. of acid-insoluble ash.

**Standard of Assay.**—The potency of *Digitalis* shall be such that when assayed as directed, 0.1 Gm. of it shall be equivalent to not less than 1.0 U.S.P. digitalis unit. One United States Pharmacopœial Digitalis Unit represents the potency of 0.1 Gm. of the U.S.P. Digitalis Reference Standard.

**Assay.**—*Digitalis* is assayed on cats. The U.S.P. method is as follows: "Proceed as directed under the Assay of *Digitalis* Tincture, weighing, to the nearest mg., at least 5 Gm. of *Digitalis*, in fine powder, in a weighing bottle, and making from it a preparation to be assayed, using the same method that is described for the Standard preparation of *Digitalis*."

**"Standard Preparation of *Digitalis*.**—Weigh the contents of one ampul of *Digitalis* Reference Standard to the nearest milligram, either in the original ampul or in a weighing bottle, and transfer to a dry, hard-glass, glass-stoppered container of at least 50-cc. capacity. Complete the weighing within 5 minutes after opening the ampul. Add sufficient menstruum consisting of 4 parts of alcohol, by volume, and 1 part of water, by volume, so that the total volume of menstruum added corresponds to 10 cc. for each Gm. of powder. Insert the stopper, the upper third of which is greased lightly with petrolatum. Shake the mixture for 24 hours,  $\pm 2$  hours, at  $25^{\circ}\text{C}.$ ,  $\pm 5^{\circ}$ , by mechanical means which continuously brings the solid material into fresh contact with the liquid phase. Immediately thereafter, centrifuge the mixture and decant into a dry, hard-glass bottle having a tight closure, and preserve under refrigeration until used. Do not use for assay after a period of more than 30 days.

**"The Cats.**—Select domestic cats free of gross evidence of disease and weighing between 1.5 and 4.0 Kg. Except that in any one assay the weight of the largest cat should not be more than twice that of the smallest cat. Do not use cats which upon gross examination are either obese, emaciated, lactating, or pregnant. Withhold food for from 16 to 28 hours prior to use. Assign all cats at random with the restriction that the two groups, the one for the standard preparation and the one for the specimen to be assayed, shall not differ by more than 50 per cent. in the average of their weights. Lightly anesthetize the cat with ether, and immobilize, preparatory to the injection. Insert a cannula in a femoral vein and arrange to inject the appropriate test dilution from a burette calibrated to 0.1 cc. after insuring the absence of air bubbles from the injection apparatus. Maintain the anesthesia throughout the injection in such a state that pain is absent, the pupillary and corneal reflexes are present, the voluntary musculature is not relaxed, and the cat occasionally moves its tail or makes some other voluntary movement.

**"Preparation of the Test Dilutions.**—Dilute the Standard Preparation of *Digitalis* and the preparation to be assayed in such a way that the estimated fatal

dose of each preparation per Kg. of cat will be diluted to 15 cc. with isotonic solution of sodium chloride. Make test dilutions the day they are to be used.



FIG. 413.—In foreground, second year plants of *Digitalis purpurea*, the common foxglove.

*“Injection of the Dilutions.*—Inject 1 cc. of the diluted material for each Kg. of the body weight of the cat, within a few seconds. Repeat this dose at 5-minute intervals until the cat dies from cessation of the heart beat.

*“Use a total of not less than 6 cats for the Standard Preparation of Digitalis*

and not less than 6 cats for the preparation to be assayed. If the average number of doses for any given dilution required to produce death is less than 13 or greater than 19, regard these data as preliminary. Use them as a guide, and



FIG. 414.—*Digitalis purpurea*. Aerial portion of second year's growth.

repeat with a fresh, higher or lower dilution. Complete the assay within a period of 15 days.

*“Calculation of the Potency.*—Express the lethal dose for each cat in terms of the cc. of tincture per Kg. of live body weight. Compute the average lethal dose of the Standard Preparation and that of the preparation to be assayed. Compute

the standard error of each average lethal dose as directed below and express each standard error as a percentage of the respective average lethal dose. If the standard error of either average exceeds 5.7 per cent., repeat the determination of the lethal dose of the Standard Preparation or of the preparation to be assayed, as the case may be, or use additional cats until the standard error falls within this limit. Express the potency of the preparation to be assayed in U.S.P. Digitalis Units per cc. by dividing the average for the Standard Preparation by the average for the preparation to be assayed.

"To compute the standard error of the average, take the difference between the average and the value found for each cat. Square these differences, take their sum, divide this sum by the number of cats, and divide this quotient by the number of cats diminished by 1. The square root of the last quotient is the standard error of the average.

"The formula for the standard error of the average (S.E.<sub>av.</sub>) is:

$$\sqrt{\frac{\text{sum } (c - \bar{c})^2}{N(N - 1)}}$$

$c$  = fatal dose for each cat.

$\bar{c}$  = average lethal dose for the group of cats.

$N$  = number of cats in the group.

"Digitalis is considered to conform to the pharmacopœial requirement if the result of the assay does not vary more than 20% from such requirement."

**Habitat.**—Europe, in meadows and pastures. Naturalized in North America.

**Plant.**—A biennial pubescent herb whose first year's aerial growth consists of a rosette of ovate-oblong leaves. During the second year a hoary stem shoots up which arises to the height of 1 to 1.5 m., bearing alternate, ovate-lanceolate to ovate-oblong, pubescent leaves and terminal racemes of purple, rarely white, tubular-campanulate flowers that are spotted within. The corolla is 4 to 5 cm. in length. The stamens are 4, didynamous. The fruit is a 2-celled pyramidal capsule.

**Production and Commerce.**—*Digitalis purpurea* is extensively cultivated in United States both as a garden ornamental and as a drug plant. It grows wild in many localities of this country as an escape from cultivation, notably in New York, Oregon and Washington. Considerable of the drug used here is obtained from plants cultivated on drug farms of United States and from plants growing wild and under cultivation in Oregon, Washington and New England. Large amounts of this drug were also imported before World War II, the foreign article coming from 1937 to 1940 from Germany, Switzerland, Netherlands, England, Belgium, Austria and Canada. During 1947, 78,547 lbs. of Digitalis were shipped to this country from Portugal, Spain, Belgium and England. It is usually shipped in drums but some of the fine English product comes in bottles.

The plants are propagated from seeds which are mixed with sand and sown in February or March in seed pans or flats in the stove house or in a hot bed.



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the standard error of each average lethal dose as directed below and express each standard error as a percentage of the respective average lethal dose. If the standard error of either average exceeds 5.7 per cent., repeat the determination of the lethal dose of the Standard Preparation or of the preparation to be assayed, as the case may be, or use additional cats until the standard error falls within this limit. Express the potency of the preparation to be assayed in U.S.P. Digitalis Units per cc. by dividing the average for the Standard Preparation by the average for the preparation to be assayed.

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$c$  = fatal dose for each cat.

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**Plant.**—A biennial pubescent herb whose first year's aerial growth consists of a rosette of ovate-oblong leaves. During the second year a hoary stem shoots up which arises to the height of 1 to 1.5 m., bearing alternate, ovate-lanceolate to ovate-oblong, pubescent leaves and terminal racemes of purple, rarely white, tubular-campanulate flowers that are spotted within. The corolla is 4 to 5 cm. in length. The stamens are 4, didynamous. The fruit is a 2-celled pyramidal capsule.

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The plants are propagated from seeds which are mixed with sand and in February or March in seed pans or flats in the stove house or in a hot bed.<sup>3</sup>

Upon the disappearance of frost, the plants should be hardened off in pots or cold frames and then transferred to the field where they should be planted about 1 to 1½ feet apart, in rows conveniently distanced for cultivation. The soil employed is of the ordinary garden kind, but should be slightly acid and must be well drained and kept as free of weeds as possible, in order to insure a good growth of plants. The leaves are gathered both from plants of the first and second year's growth. The best time to collect leaves from the second year's growth is in June, before the expansion of the flowers. These leaves are averagely richer in glycosides than leaves collected often after the flowers have opened. They are carefully dried on trays with mesh-wire bottoms arranged in vertical series through which warm air currents pass from below in drying houses with a good circulation of air. They must not contain more than 6 per cent. of moisture before marketing. An excellent deep green product has recently been produced by the method of dehydration. They should be preserved in tightly-closed containers protected from light. *See also Storage.*

*Digitalis* plants, when grown in regions where hot dry periods prevail in summer, is subject to severe damage from attacks by the spider mite, a pest difficult to control during the first year's growth of the plants owing to the large, closely-spaced leaves forming a dense rosette which does not admit of ready access of the insecticide. For this reason, the crop does best in the north.

Hamilton\* has shown that the fresh leaves have greater toxicity than the dried leaves and that no more highly toxic products than those present in the crude drug are developed during the drying process.

**Description.**—Leaves usually more or less crumpled and broken; blades ovate, oblong-ovate to ovate-lanceolate, when entire, mostly 10 to 35 cm. in length and 4 to 11 cm. in width and abruptly contracted at bases into winged petioles, the latter from 5 to 10 cm. in length and up to 3 cm. in breadth or, in the smaller upper leaves, nearly absent; margin irregularly crenate or dentate; apex obtuse; upper surface dark green, wrinkled and sparsely hairy; lower surface dull, pale green to grayish and soft pubescent; venation pinnate-reticulate, the midrib and principal veins broad and flat, often purplish, the lower veins continued into the wing of the petiole; odor slight when dry, peculiar and characteristic when moistened; taste bitter.

**Storage and Labeling.**—Under all conditions of storage and transportation, *Digitalis* must be preserved under such conditions as will maintain not more than the specified moisture content, provided that *Digitalis* to be used exclusively for the manufacture of glycosides and labeled "*Digitalis*—To be used only in the manufacture of glycosides," is exempt from the storage and moisture requirements. A suitable cartridge containing a non-liquefying, inert, dehydrating substance, such as silica gel may be inserted in the container to maintain low humidity.

**Histology.**—Transverse and surface sections of the lamina of Foxglove leaves present the following tissues for examination:

\* American Jour. Pharm., Vol. 91, p. 177, 1919.

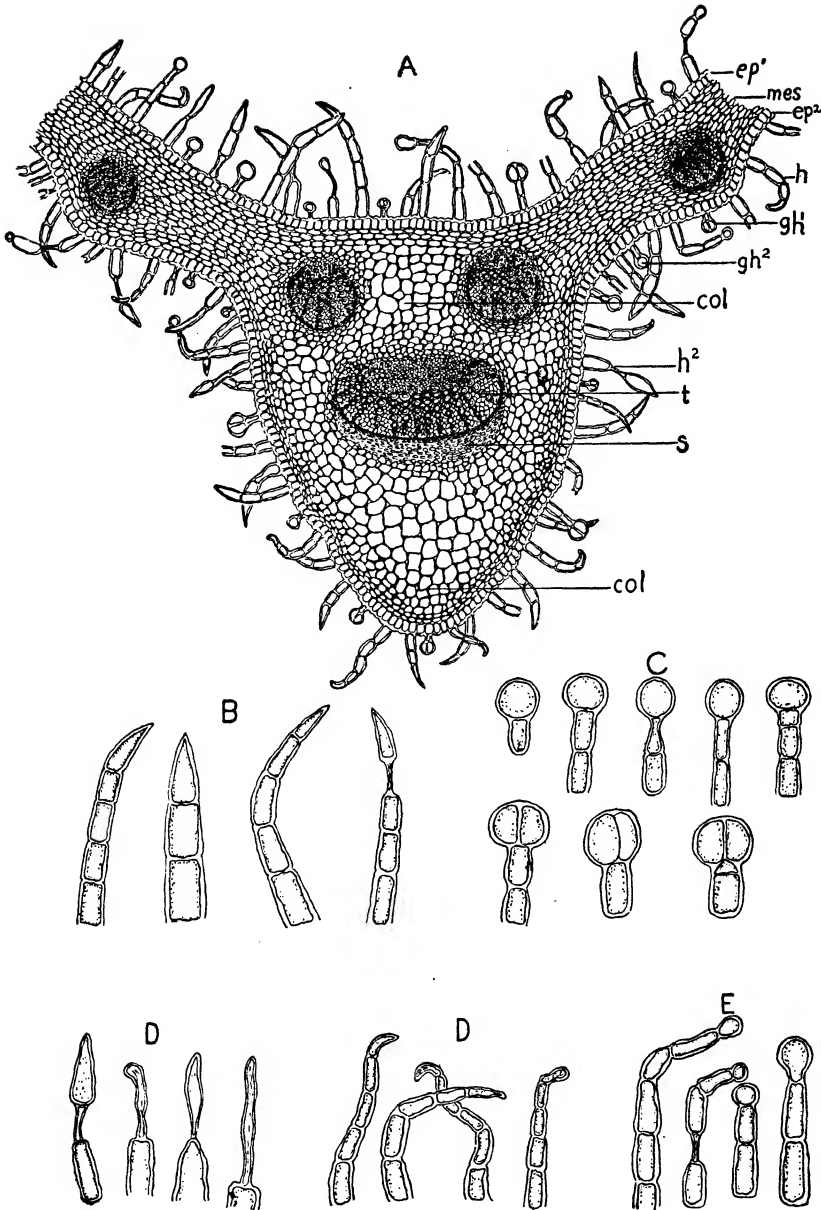


FIG. 415.—A, Transverse section through a stronger vein and portion of lamina of *Digitalis* leaf. Upper epidermis (*ep*<sup>1</sup>); mesophyll (*mes*); lower epidermis (*ep*<sup>2</sup>); non-glandular hairs (*h* and *h*<sup>2</sup>); glandular hair with 1-celled stalk and 2-celled head (*gh*<sup>1</sup>); glandular hair with 1-celled stalk and 1-celled head (*gh*<sup>2</sup>); collenchyma (*col*); tracheae (*t*) and sieve tissue (*s*) of bundles. B and D, Various types of uniseriate non-glandular hairs of digitalis. C, Types of glandular hairs of digitalis. E, Glandular hairs found on leaves of cultivated digitalis plants.

1. *Upper epidermis* of slightly wavy-walled, clear epidermal cells, no stomata but numerous hairs, as seen in vertical view.

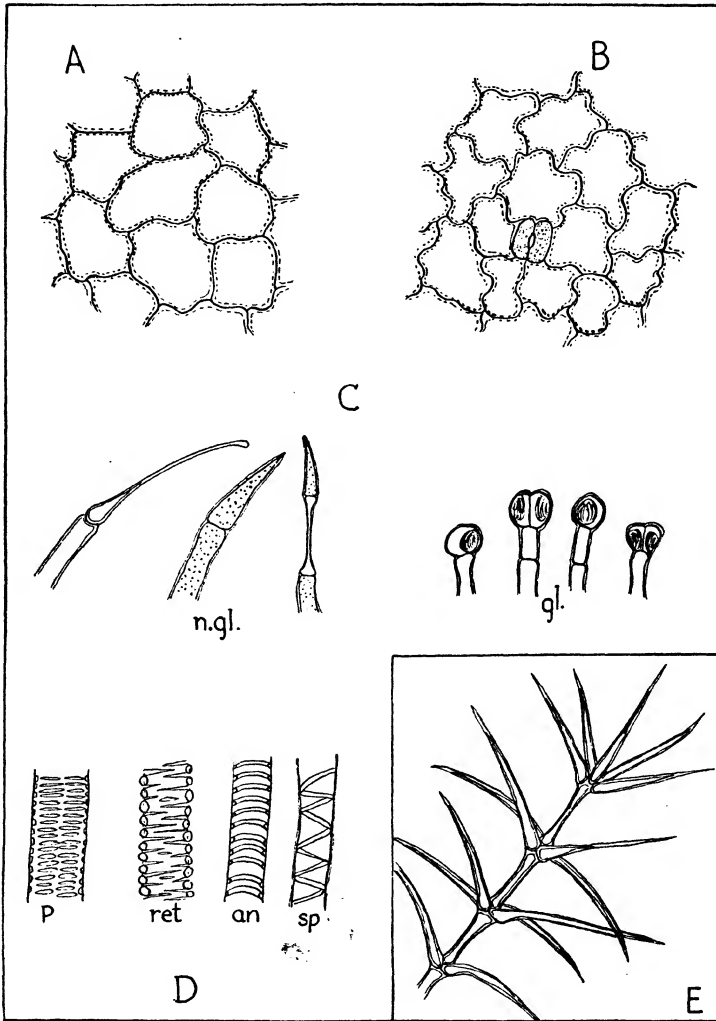


FIG. 416.—A, B, C, D, Powdered *Digitalis*. A, upper epidermis; B, lower epidermis; C, hairs; n.gl., non-glandular hairs; gl., glandular hairs; D, tracheae; p, pitted trachea; ret, reticulate trachea; an, annular trachea; sp, spiral trachea; E, candelabra-shaped trichome of Mullein leaf. (Drawing by Barbara Jacobs.)

2. *Mesophyll* of a layer of short palisade cells and several layers of irregularly arranged more or less rounded spongy parenchyma cells rich in chloroplastids. In the midrib and stronger veins, this region shows a half circle of fibrovascular bundles, the xylem portion of each group of which is fan-shaped, and consists of rows of tracheae separated by narrow medullary rays 1 cell wide. In these

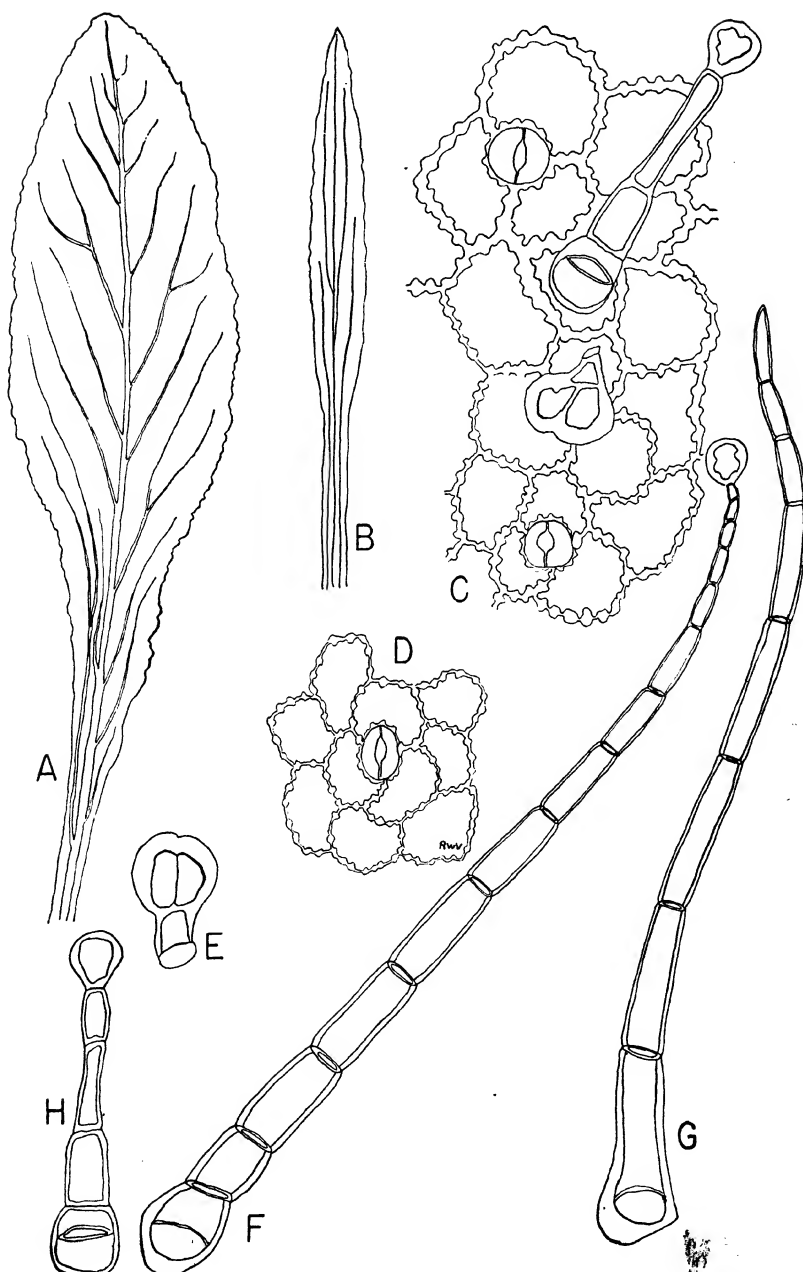


FIG. 417.—*Digitalis* Leaves. A, Leaf of *Digitalis purpurea*. B, Leaf of *Digitalis lanata*. C, lower epidermis and D, upper epidermis of *Digitalis lanata*. E, a glandular hair of *D. purpurea*. F, H, glandular hairs of *D. lanata*. G, non-glandular hair of *D. lanata*. Epidermal fragments and hairs magnified. (Drawing by R. W. Vander Wyk.)

parts, also, collenchymatous differentiation of the mesophyll is observed beneath each epidermis.

3. *Lower epidermis* of prominent wavy-walled epidermal cells, numerous oval stomata, and many hairs. This epidermis is frequently not attached over irregular areas to the cell area within, especially near some of the veins.

Non-glandular and glandular hairs are evident as outgrowths of cells of both epidermises. The non-glandular hairs are uniseriate, frequently curved or crooked, 2- to 8-celled, one or more of the cells being collapsed. The glandular hairs exhibit a one to two celled stalk and a one to two celled glandular head. Water stomata are present on the marginal teeth.

**Ground Drug.**—Dark green; numerous fragments of mesophyll, the cells of which are devoid of calcium oxalate but contain abundant chloroplastids; numerous fragments of uniseriate, non-glandular hairs, frequently curved or crooked, consisting of from 2- to 8-cells (usually 2- to 5-cells), some of the cells being frequently collapsed; few small glandular hairs, with a 1- to 2-celled stalk and a 1- to 2-celled glandular head; numerous fragments of epidermis with cells having undulate vertical walls and often showing stomata; fragments of veins and petioles exhibiting fibrovascular elements including tracheæ with annular, reticulate or spiral thickenings or with simple pores; no stone cells.

**Powdered Digitalis (Digitalis Pulverata) U.S.P.** is *Digitalis*, dried at a temperature not exceeding 60°C. and reduced to a fine powder and adjusted, if necessary, to conform to the official potency by admixture with sufficient lactose, starch or exhausted marc of digitalis, or with a powdered digitalis having either a lower or a higher potency. It must be preserved in tight, light-resistant containers. A suitable cartridge or device, containing a non-liquefying, inert, dehydrating agent may be used in the container to maintain low humidity. It contains not more than 5 per cent. of moisture. The U.S.P. directs that it is to be dispensed when *Digitalis* is prescribed. Its potency shall be such that 0.1 Gm. of it, when assayed as directed, shall possess an activity equivalent to not less than 1.0 U.S.P. *Digitalis* Unit. For description see *Ground Digitalis*.

**Constituents.**—The glycosides *gitalin* (*digitalein*), *digitoxin*, *digitalin*, *gitoxin*, *Purpurea-glycoside A* and *Purpurea-glycoside B*; the saponins *digitonin*, *digitsaponin* and *gitin*; volatile oil containing digitalosmin; tannin, an irritant resin termed digitalic acid, a yellow coloring substance termed digitoflavone or luteolin, an oxydase, etc. The most powerful constituent is *digitoxin* ( $C_{41}H_{64}O_{14}$ ), a crystalline substance composed of the aglycone digitoxigenin combined with 3 molecules of the methylaldopentose, digitoxose. It is soluble in alcohol and chloroform, nearly insoluble in water, slightly soluble in ether and insoluble in petroleum benzene. *Purpurea-glycoside A*, when hydrolyzed by an enzyme in the leaf, yields digitoxin and glucose. *Purpurea-glycoside B*, when hydrolyzed, yields gitoxin and glucose.

*Gitalin* ( $C_{36}H_{56}O_{12}$ ) occurs as a white or faintly buff-colored powder soluble in alcohol and chloroform and slowly soluble in 600 parts of cold water.

Several "digitalins" occur in commerce which vary in their composition. Nativelle's digitalin is chiefly digitoxin. Homolle's digitalin represents a

mixture of digitoxin and digitalin. German digitalin (*Digitalinum Germanicum*) is a mixture of glycosides obtained from digitalis seeds, consisting largely of digitonin, with true digitalin and other glycosides. *Digitalinum Verum*, Kilani or True digitalin is pure amorphous digitalin having the chemical formula of  $(C_{45}H_{80}O_{21})_7$ . Baljet\* determined the localization of the glycosides in the leaves of several species of *Digitalis* including *D. purpurea* by means of sodium picrate reagent (a mixture of 1 drop of a 1 per cent. picric acid solution with 1 drop of a 10 per cent. solution of sodium hydroxide). He found that when sections were mounted in this reagent, the cells containing the glycosides were colored orange within one or two minutes. These glycosides were thus located in the non-glandular hairs, epidermal cells, endodermis, surrounding the vascular bundles and occasionally in the subepidermal collenchyma.

**Uses.**—*Digitalis* is extensively used as a cardiac stimulant and tonic and as a diuretic.

**Preparations of Digitalis.**—Powdered *Digitalis*, U.S.P., 0.1 Gm. ( $1\frac{1}{2}$  grains); *Digitalis* Tablets, U.S.P., *Digitalis* Capsules, U.S.P.; *Digitalis* Tincture, 1 cc. (15 minims); *Digitalis* Injection (the dose recommended on the label); *Digitalis* Extract, N.F., 30 mg. ( $\frac{1}{2}$  gr.); *Digitalis* Infusion, N.F. (from U.S.P. Powd. *Digitalis*), 6 cc. ( $1\frac{1}{2}$  fl. dr.).

**Adulterants.**—(1) Mullein leaves (*Verbascum* species) readily distinguished from *Digitalis* by the presence of numerous candelabra-shaped, branching hairs.

(2) Leaves of *Inula Conyza* (Fam. *Compositæ*), the non-glandular hairs of which are thicker-walled, 3- to 4-celled, the basal cell being broad. The margins are entire or dentate, the teeth with horny points.

(3) Leaves of *Salvia Sclarea* or Muscatel Sage (Fam. *Labiatae*) which have cordate bases, long petioles and glandular hairs with 8-celled heads.

(4) Leaves of *Symphytum officinale* or Comfrey (Fam. *Boraginaceae*) which are ovate-lanceolate and possess stiff scattered hairs.

(5) Leaves of *Digitalis Thapsi* L. or "*Spanish Digitalis*." The plant is a native of the Balkans and Pyrenees. Its leaves vary from lanceolate to oblanceolate or ovate, are up to 15 cm. in length and 5 cm. in width, dark yellowish green, irregularly serrulate to denticulate, densely pubescent with glandular hairs on both surfaces, but devoid of non-glandular hairs. They possess prisms of calcium oxalate in the mesophyll and pericyclic fibers in the midrib.

**Allied Species.**—*Digitalis lanata* Ehrh. or Grecian Foxglove, a perennial or biennial herb native to the Danube region and Greece. It is characterized by having light grayish-green, nearly glabrous, decurrent, sessile, oblanceolate to lanceolate leaves with an entire or slightly toothed margin and small creamy yellow or purple flowers. As shown by Dewar and Wallis, the upper and lower epidermis in surface view possess distinctly beaded, slightly sinuous walls and the non-glandular hairs are few, uniseriate and up to 14 cells in length. The leaves contain the crystalline glycosides *digitoxin*, *gitoxin* and *digoxin* each

\* Schweiz. Apoth. Zeitung, 56; p. 247, 1918.



occurring free as well as combined with an acetyl group and a molecule of dextrose. In the combined form, these substances are known respectively as *Lanatosides A, B, and C*. This drug acts similarly to *Digitalis* but has been found to be from 2 to 5 times as potent.



FIG. 418.—*Digitalis Thapsi* L. or Spanish Digitalis. Second year plant cultivated by the author in Boston, Mass.  $\times \frac{2}{3}$ . The leaves of this species have recently occurred as a fraudulent substitute for U.S.P. *Digitalis*.

Lanatoside A is composed of digitoxigenin, digitoxe, dextrose and an acetyl group. It is changed to Purpurea glycoside A by deacetylation and reduced to digitoxin by the action of an enzyme. Lanatoside B is an acetylated Purpurea glycoside B which yields gitoxin on deacetylation and enzyme hydrolysis.

Lanatoside C is an acetylated glycoside of digoxigenin yielding digoxin on deacetylation and enzymic hydrolysis.

#### DIGITALIS GLYCOSIDES AND THEIR PREPARATIONS

**Digitoxin (Digitoxinum)** U.S.P. is either pure digitoxin ( $C_{41}H_{64}O_{13}$ ) or a mixture of cardioactive glycosides obtained from *Digitalis purpurea* L. (Fam. *Scrophulariaceæ*) and consisting chiefly of digitoxin. Its potency corresponds to an equal weight of Digitoxin Reference Standard of the U.S.P. It occurs as a white to pale buff, odorless crystalline powder which is insoluble in water. 1 Gm. dissolves in about 60 cc. of alcohol. It is used for the rapid digitalization of the heart in cardiac disease and as a substitute for Digitalis in case the latter occasions gastric irritation. It is a powerful myocardial stimulant. It is extremely poisonous. The duration of its action is prolonged, often 2 or 3 weeks from a single dose.

**Average Dose.**—Oral, 0.1 mg. ( $\frac{1}{600}$  grain); Intravenous, to be determined by the physician.

Preparations in U.S.P.—Digitoxin Injection, a sterile solution of digitoxin in 40 to 50 per cent alcohol. It is administered intravenously, the dosage to be determined by the physician. Available in vials containing 0.2 mg. in 1 cc. and 0.4 mg. in 2 cc.

Digitoxin Tablets, available in 0.1 and 0.2 mg. sizes.

**Digoxin (Digoxinum)** U.S.P. is a glycoside obtained from the leaves of *Digitalis lanata* Ehrh. (Fam. *Scrophulariaceæ*). It occurs as colorless and odorless white crystals or powder which are insoluble in water but soluble in dilute alcohol. Cardiac tonic and used like digitoxin in the rapid digitalization of the heart. **Average Oral Dose.**—0.5 mg. ( $\frac{1}{120}$  gr.). U.S.P. Preparations.—Digoxin Injection which is a sterile solution of digoxin in 70 per cent alcohol. Av. Dose to be determined by the physician. It is administered intravenously and is available in ampuls containing 0.5 mg. of digoxin in 1 cc. It is extremely poisonous. The duration of its action is about 3 days. Since it is a tissue irritant, the contents of the ampul should be diluted with 10 cc. of sterile isotonic salt solution before injection. Digoxin Tablets. Av. Dose of Digoxin, 0.5 mg. ( $\frac{1}{120}$  gr.).

**Lanatoside C (Lanatosidum C)** U.S.P. is a glycoside obtained from the leaves of *Digitalis lanata* Ehrh. (Fam. *Scrophulariaceæ*). It occurs as colorless or white crystals or as a white crystalline powder. 1 Gm. dissolves in 20,000 cc. of water, and in 45 cc. of alcohol. It is used as a myocardial stimulant in digitalization of the heart, in threatened cardiac failure. **Average Dose, Oral,** 0.5 mg. ( $\frac{1}{120}$  grain); Parenteral, to be determined by the physician. U.S.P. Preparations.—Lanatoside C Injection which is a sterile solution of Lanatoside C in 10 per cent by volume of alcohol. It is available in ampuls containing the following amounts of lanatoside C: 0.4 mg. ( $\frac{1}{150}$  grain) in 2 cc. and 0.8 mg. ( $\frac{1}{80}$  grain in 4 cc.). Av. Dose.—To be determined by the physician. \*Lanatoside C Tablets. Av. dose of Lanatoside C, Oral, 0.5 mg. Lanatoside C is now available as **Cedilanid (Sandoz)**.

## LEPTANDRA N.F. (LEPTANDRA)

**Synonyms.**—*Culversroot*, Culver's Physic, Tall Speedwell or Veronica; *Fr.* Racine de Véronique; *Ger.* Leptandrawurzel.

**Botanical Origin.**—*Veronicastrum virginicum* (L.) Farwell. (*Veronica virginica* Linné; *Leptandra virginica* Nutt.).

**Part Used.**—The dried rhizome and roots.

**Purity Rubric.**—Not more than 5 per cent. of attached stem bases and not more than 2 per cent. of other foreign organic matter; it yields not more than 6 per cent. of acid-insoluble ash.



FIG. 419.—Leptandra,  $\times 2\frac{1}{2}$ s. (Photograph by Stoneback.)

**Habitat.**—In low grounds of Canada and United States as far south as Alabama and west to Minnesota and Nebraska.

**Plant.**—A perennial herb with erect, quadrangular stem attaining a height of 1 to 2 m. The leaves are whorled in 4's or 7's, lanceolate and serrulate. The flowers are small, pinkish to nearly white and arranged in spikes which are paniced. The fruit is an oblong-ovate capsule, opening by 4 apical teeth.

**Production and Commerce.**—The rhizomes and roots should be collected from plants of the second year's growth. Most of the drug is gathered in the Southern Appalachian district.

**Description.**—Rhizome of horizontal growth; nearly cylindrical, somewhat branched, the branches readily separable from the main rhizome; up to 10 cm. in length and from 4 to 14 mm. in diameter, externally weak brown to moderate yellowish-brown, annulate from circular scars of bud scales; upper surface showing hollow stem bases, buds and circular stem scars; lower and lateral surfaces beset with wrinkled, fragile, rigid roots or remnants of these; fracture of rhizome,

very tough, woody and uneven; internally bark thin, brown and resinous, wood nearly the same thickness as bark, yellowish white to light brown and porous, pith large, brown and more or less hollow. Roots up to 10 cm. in length and from 0.5 to 2 mm. in diameter, of the same color as rhizome, smooth or faintly longitudinally wrinkled; fracture short; internally showing a thick dark-colored

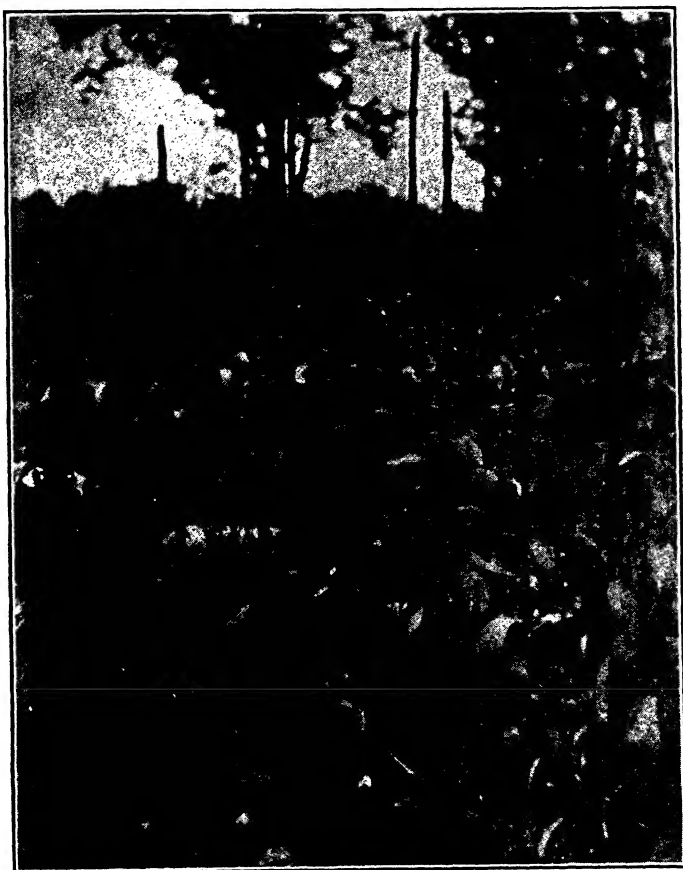


FIG. 420.—A group of Mullein plants (*Verbascum Thapsus*) in their second year's growth.

cortex and a small, light-colored central cylinder; fracture of roots short; odor indistinct unless powdered, then characteristic, taste very bitter and acrid.

**Constituents.**—*Resin*, tannin, a bitter amorphous substance, volatile oil, verosterol, sugar, 3:4-dimethoxycinnamic acid, etc. *Leptandrin* is an impure resin obtained by precipitating a strong alcoholic tincture of the drug with water.

**Use.**—Cholagogue cathartic. In large doses it acts as an emetic.

**Average Dose.**—1 Gm. (15 grains).

**Preparations.**—Leptandra Extract, N.F., 0.25 Gm. (4 grains); Fluidextract of Leptandra (unof.), 1 cc. (15 minims); Compound Colocynth and Jalap Pills, N.F. (from Ext.), 1 pill.

## MULLEIN LEAVES (VERBASCI FOLIA)

**Synonyms.**—Common Mullein, Velvet Dock; *Ger.* Wollkraut; *Fr.* Bouillon-blanc.

**Botanical Origin.**—*Verbascum Thapsus* Linné and other species of *Verbascum*.

**Part Used.**—The dried leaves.

**Habitat.**—Europe.

**Plant.**—*Verbascum Thapsus* or common mullein is a densely woolly biennial herb growing in waste places and fields, where it has become widely naturalized in this country and Canada. Its leaves are ovate-oblong, tomentose, acute and appear as a rosette above ground during the first year. During the spring or early summer of the second year a long woolly stem shoots up to the height of 1.3 m. bearing tomentose, decurrent leaves along the greater portion of its length and ending in a long, dense cylindrical spike of yellow flowers.

**Description.**—Leaves greenish or yellowish gray, entire and crumpled or broken, sessile, oblong, oblong-lanceolate with entire margin and densely tomentose surfaces, the latter due to long, branching, multicellular, non-glandular, candelabra-shaped hairs; odor indistinct; taste mucilaginous and slightly bitter.

**Powdered Drug.**—Dark green. The most diagnostic structure is the slightly-lignified, candelabra-shaped, non-glandular hair. (See Fig. 416E.) This consists of a jointed central axis with whorls of 2 to 8 lateral cells arising at the joints or summit. Glandular hairs with a 1-celled stalk and 1-celled head are also present.

**Constituents.**—*Mucilage*, a trace of volatile oil, resin, tannin wax, etc.

**Uses.**—Demulcent and emollient.

**Average Dose.**—4 Gm. (60 grains).

**Allied Drug.**—**Mullein Flowers** (*Verbasci Flores*) consists of the dried corollas and adhering stamens of *Verbascum phlomoides* L. or *V. thapsiforme* Schroeder, biennial herbs native to Europe and Asia. It contains volatile oil, mucilage, resin, fixed oil, sugar, etc.

## PEDALIACEÆ (SESAME FAMILY)

A family of tropical herbs often covered with viscous hairs. Leaves usually alternate, more rarely opposite, exstipulate. Flowers irregular, pentamerous. Fruit a capsule (*Sesamum*, etc.), a drupe, or rarely a one-seeded, indehiscent nut. Seeds usually exalbuminous.

## SESAME OIL U.S.P. (OLEUM SESAMI)

**Synonyms.**—Teel Oil, Benne Oil, Gingelly Oil; *Ger.* Benne-Oel.

**Botanical Origin.**—One or more cultivated varieties of *Sesamum indicum* Linné.

**Part Used.**—The fixed oil obtained from the seeds.

**Habitat.**—Asia. Naturalized in Southern United States and widely cultivated in the orient.

**Plant.**—An annual herb up to 2 ft. in height with branched stem bearing opposite usually 3-lobed or parted lower leaves and alternate upper leaves of oblong-lanceolate shape with cordate base. The flowers are solitary in the leaf axils, and tubular, of a pale rose or white color. The fruit is an oblong capsule containing small, flattened obovate to pear shaped, yellowish-white, brown, reddish or black seeds, the color varying with the variety.

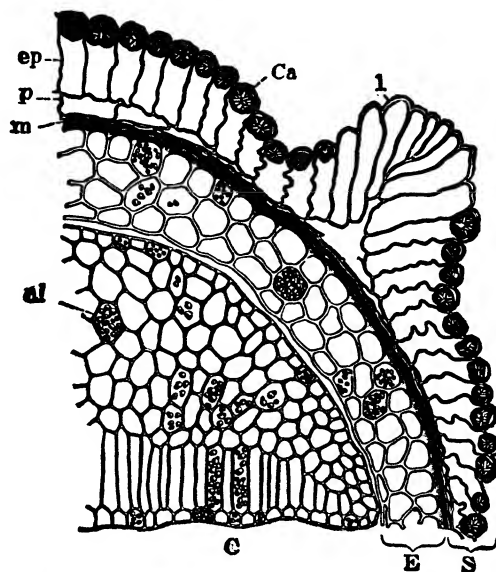


FIG. 421.—Sesame seed. Representative portion of cross section. S, spermoderm consists of ep epidermal cells with Ca crystal masses, l epidermal cells of ridges, p parenchyma and m yellow membrane; E, endosperm; C, cotyledon containing al aleurone grains.  $\times 160$ . (From Winton's "Microscopy of Vegetable Foods," John Wiley & Sons, Inc.) (This work is permanently out of print.)

**Production and Commerce.**—The plants grow wild in India and are also cultivated in India, China, Japan, Netherlands Indies, Kwantung, Mexico, Central America, Portuguese Africa, Brazil, West Indies and many other tropical and subtropical countries for their seeds, fixed oil and oil cake which are used as food. The seeds are small, flattened pear-shaped 1.5 to 4 mm. long, 1 to 2 mm. broad and about 1 mm. thick, show 4 longitudinal ridges and a raphe passing lengthwise through the center of one of the flattened sides. They contain about 50 per cent. of fixed oil. The fixed oil, obtained from the seeds by expression, represents a non-drying oil which is used for cooking as an ingredient of confectionery, as a substitute for olive oil, and for anointing. During 1939, 3,519,669 lbs. of this oil were imported from Netherlands, Netherlands Indies, Syria, Denmark, Iran and Palestine. In the same year, 10,055,309 lbs. of sesame seed were imported most of which came from China, British India, Portuguese Africa, Brazil, Central America, West Indies and Japan. During 1947, only 32,005 pounds of sesame oil were imported, the supplies coming from China and Mexico. The importations of sesame seed during 1947 were 9,491,-

208 pounds which came from Central America, Ecuador, Brazil, China, Siam, Hongkong, Syria, and Dominican Republic.

**Description.**—A pale yellow to almost colorless, oily liquid with a bland taste, slightly soluble in alcohol and miscible with ether, chloroform, petroleum benzene and carbon disulfide; sp. gr. 0.916 to 0.921 at 25°C.

**Identity Test.**—Shake 1 cc. of sesame oil for half a minute with a solution of 0.1 Gm. of sugar in 10 cc. of HCl. The acid layer becomes bright red, changing to dark red on standing.

**Constituents.**—The glycerides of oleic, linolic, palmitic, stearic and myristic acids; sesamin, a phenolic substance called sesamol, etc.

**Uses.**—Emollient and nutrient, as a substitute for olive oil, and in the manufacture of penicillin injection in oil and wax U.S.P. and ammonia liniment N.F.

**Adulterant.**—Cottonseed Oil. This may be detected by mixing 5 cc. of the suspected oil in a test tube with 5 cc. of a mixture of equal volumes of amyl alcohol and a 1 per cent. solution of sulfur in carbon disulfide, immersing the test tube to  $\frac{1}{3}$  of its depth in a boiling saturated aqueous solution of salt, when, if cottonseed oil is present, a reddish color will develop within 15 minutes.

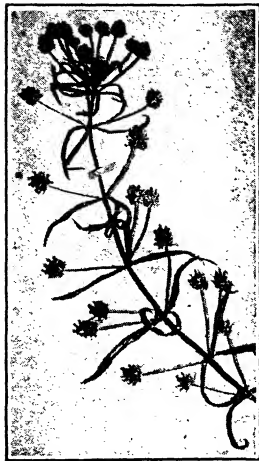


FIG. 422.—*Plantago Psyllium* L. Upper portion of leaf and flowering plant.  $\times \frac{1}{4}$ .

#### PLANTAGINACEÆ (PLANTAIN FAMILY)

Annual or perennial herbs of caulescent (*Plantago Psyllium*, etc.) or more usually acaulescent habit (*Plantago major* or Common Plantain, etc.), rarely sub-shrubs. Leaves all radical in most species, or in a rosette, alternate or opposite to whorled, simple, nerved, flat, entire or toothed. Flowers usually hermaphroditic, regular, tetramerous and arranged on spikes; calyx of 4 sepals, corolla gamopetalous, hypogynous, tubular with a 4-lobed limb; stamens 4, epipetalous; carpels 2 or 1, the ovary 1 to 4 celled, ovules 1 to 8 in each cell, peltate on the middle of the septum in many ovuled cells or at the bottom of 1-ovuled cells; style filiform with 2 lines of stigmatic papillæ.

Fruit a pyxis in Plantains, rarely a bony nucule. Seeds albuminous with a straight (*Plantago*) to curved (*Bougueria*) embryo.

#### PLANTAGO SEED N.F. (PLANTAGINIS SEMEN)

**Synonyms.**—*Psyllium Seed*, *Plantain Seed*, Flea Seed; *Ger.* Flohsamen; *Fr.* Semences de Psyllium.

**Botanical Origin.**—(1) *Plantago Psyllium* L.; (2) *Plantago indica* L. [*Plantago arenaria* Waldstein et Kitaibel; *P. ramosa* (Gilib.) Aschers]; (3) *Plantago ovata* Forskal.

**Habitat.**—1 and 2. Mediterranean countries. 3. Asia, southern Europe, North Africa.

**Part Used.**—The cleaned, dried, ripe seed.

**Purity Rubric.**—*Plantago* seed contains all of its natural mucilage. It contains not more than 0.5 per cent. of foreign organic matter. It yields not more than 4 per cent. of total ash and not more than 1 per cent. of acid-insoluble ash.

**Plants.**—*Plantago Psyllium* L., the source of the best Spanish Psyllium seed, is an annual, erect, glandular-hairy caulescent herb, with an erect branching stem, 0.2 to 0.4 m. in height. It possesses whorls of flattened linear to linear-lanceolate leaves from the upper axils of which flowering stalks as long as the leaves arise. These stalks terminate in ovate-elliptical spikes. The spikes are up to 12 mm. long, the lower bracts ovate-lanceolate, up to 6 mm. in length with a herbaceous midrib extending as a long cusp, the lamina hyaline laterally and bearing along the margin and midrib of the dorsal surface numerous glandular and non-glandular hairs; the upper bracts ovate-lanceolate up to 4 mm. in length and somewhat similar in character to the lower but with chloroplastids fewer in the midrib of the proximal portion. The flowers are tetramerous with a calyx of 4 similar persistent, lanceolate sepals, each with green midrib and hyaline lamina, a hypocrateriform corolla of 4 gamopetalous hyaline petals inserted below the ovary, the tube surrounding the ovary and a portion of the filiform, hairy style, the limb with 4-lanceolate, acuminate lobes. The fruit is a membranous, 2 celled and 2 seeded pyxis.



FIG. 423.—*Plantago arenaria* W. et K. Upper portion of leaf and flowering plant.  $\times \frac{1}{4}$ .

*Plantago indica* L. (*P. arenaria* W. et K.), the Sandwort or Whorled Plantago, chief source of French Psyllium seed, is an annual caulescent herb attaining a height of 0.3 to 0.5 m. with an erect or diffuse, hairy, frequently branched stem with whorls of linear to filiform leaves, from the axils of the upper ones of which spring peduncles which are longer than the leaves and more or less umbellate. Each ends in an oblong-ovate spike up to 20 mm. in length. The lower bracts are transversely ovate below, lanceolate above, with an herbaceous midrib and hyaline margin, glandular hairy, the upper bracts broadly ovate with obtuse summits and also have herbaceous midribs and hyaline margins. The calyx is persistent, hairy, of 2 large spatulate anterior segments and 2 smaller, lateroposterior, lanceolate segments. The corolla is hypocrateriform of 4 petals, the limbs oblong with acute to mucronate summits; the tube of the corolla covering the pyxis and portion of the style. The pyxis is membranous, 2 celled, 2 seeded, and dehisces about or slightly below the middle.

*Plantago ovata* Forskal, the source of Blonde Psyllium seed, is an annual, acaulescent herb with narrow linear to lanceolate leaves which have entire or irregularly toothed margins and scapes as long or longer than the leaves. Each scape terminates in an ovate to oblong spike consisting of spirals of rounded



ovate bracts subtending flowers. The sepals are characterized by a distinct midrib extending from the base to the summit; the petal lobes are oval with a mucronate summit.

**Production and Commerce.**—The seeds of *Plantago Psyllium* have been marketed under the names of Spanish-, French-, and Brown-Psyllium seed or

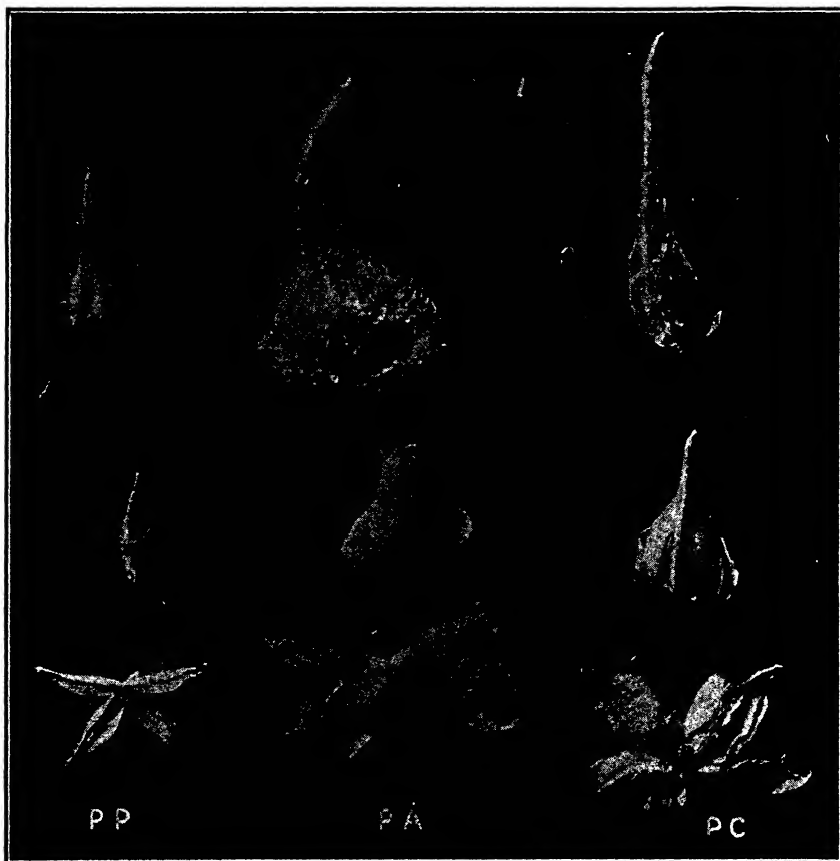


FIG. 424.—Floral parts of three caulescent species of *Plantago*. PP, *Plantago Psyllium*; PA, *Plantago arenaria*; PC, *Plantago Cynops*. Top row, lower bracts; middle row, upper bracts; bottom row, calyces.

**Flea seed.** Most of the American supply of this seed has been obtained from plants cultivated in Spain, a lesser amount from plants cultivated in France. The seeds of *Plantago arenaria* are obtained from plants cultivated chiefly in France, the district of Carpentras being the chief center, to a lesser extent in Spain and Greece. They were formerly also collected from plants grown in Italy. The seeds are commercially known as French-, Spanish-, Black-, Brown-Psyllium and Flea seed. The seeds of *Plantago ovata* are obtained from plants cultivated in India and are known commercially as Blonde Psyllium, White Psyllium Seed, White Flea Seed, Ispaghula Seed and Indian Plantago Seed.

Psyllium Seed is imported from France, British India, and Spain. During 1945, 1,485,013 pounds were imported into the U.S.A.

**Description and Physical Properties.** *Plantago Psyllium Seed*.—Hemianatropous, silky to the touch, ovate to ovate-elongate, larger at one extremity than the other, concavo-convex, light brown to moderate brown, dark brown along the margin, very glossy; mostly from 1.28 to 2.72 mm., rarely up to 3 mm. in

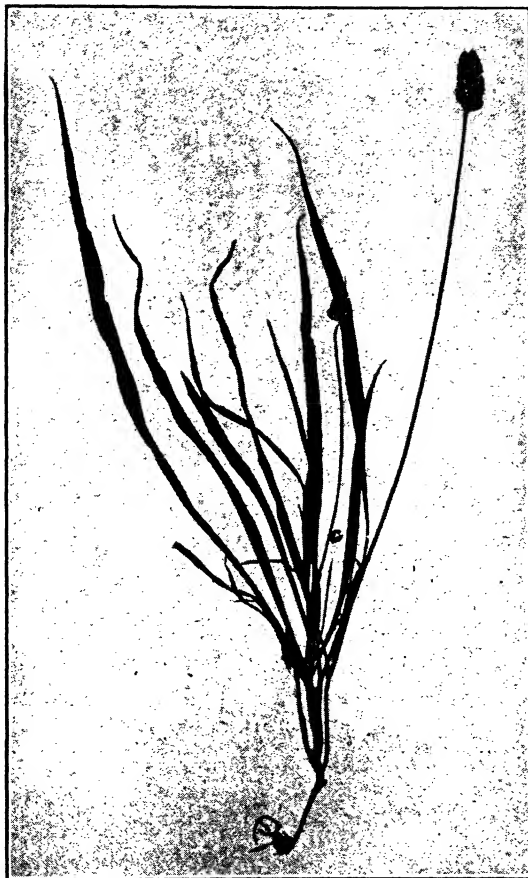


FIG. 425.—*Plantago ovata* Forsk., the source of Blonde Psyllium seed.  $\times \frac{1}{2}$ .

length, and from 0.6 to 1.12 mm. in breadth, the convex dorsal surface somewhat transparent, exhibiting a longitudinal brown area extending nearly the length of the seed and representing the embryo lying beneath the seed coat, and a transverse groove nearer the broader than the narrower extremity and over the point of union of the hypocotyl and cotyledons; the concave ventral surface with a deep excavation, in the center of the base of which is an oval yellowish white hilum. Upon soaking in water, the seed coat swells and the seed becomes enveloped with a colorless mucilage.

*Plantago indica* Seed.—Ovate-oblong to elliptical; externally dark brown to maroon, less shiny than the former species, often dull, rough and reticulate, from 1.6 to 3 mm. in length and from 0.96 mm. to 1.5 mm. in breadth; concavo-convex, the dorsal surface with a longitudinal light brown area extending lengthwise along the center and beneath the seed coat and a median transverse groove, dent or fissure; the ventral surface with a deep concavity, the edge of which is somewhat flattened and frequently forms a sharp indented angle with the base of the cavity, the latter showing a pale brown to occasionally a whitish

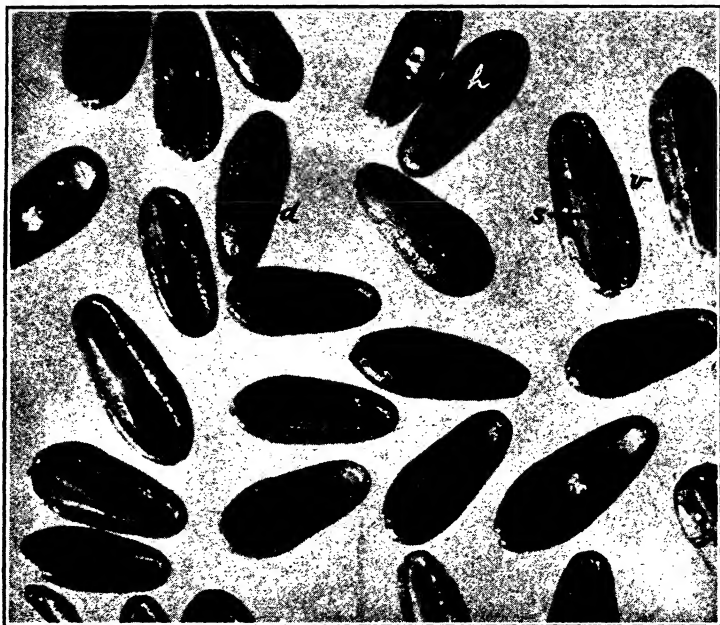


FIG. 426.—*Plantago Psyllium* seed.  $\times 8.5$ . *d*, dorsal side; *v*, ventral side; *h*, region of hypocotyl; *cc*, region of cotyledons toward narrower end; *s*, hilum.

oval hilum. Upon soaking in water, the seed coat swells and the seed becomes enveloped with a colorless mucilage.

*Plantago ovata* Seed.—Broadly elliptical to ovate, boat-shaped, pale grayish-brown with a pinkish tinge and with a dull surface, from 2 to 3.5 mm. in length and from 1 to 1.5 mm. in width; the convex dorsal surface with a small, elliptical or elongated, shining reddish-brown spot, the concave ventral surface with a deep excavation, in the center of the base of which occurs a hilum covered with a thin, whitish membrane. Upon soaking the seeds in water, the outer epidermis of the seed coat swells and the seed becomes enveloped with a thick layer of clear mucilaginous jelly, the reddish-brown spot is lost, the whole surface of the seed appearing reddish-brown.

**Histology.**—Transverse sections of *P. Psyllium* seeds cut through the central region possess a reniform outline and present for examination a spermoderm,

725/

endosperm and embryo. The *spermoderm* shows (1) an *outer epidermis* of mucilaginous epidermal cells with more or less obliterated walls in glycerin mounts, the radial and inner walls of which swell and disintegrate to form a clear mucilage upon irrigation of the mount with water, (2) a *pigment layer* with brown amorphous content. Directly beneath the spermoderm lies the broad *endosperm*, composed of irregular shaped, thick-walled cells with walls of reserve cellulose. The outer layer of this region consists of palisade cells which range from  $15\mu$  to  $34\mu$ , rarely to about  $40\mu$  in height. The contents of these



FIG. 427.—*Plantago indica* (*P. arenaria*) seed.  $\times 9$ . Most of the French Psyllium seed is of this source.

endosperm cells consist of aleurone grains and fixed oil. Protoplasmic connections are visible between some of the endosperm cells in thin sections.

(3) The straight embryo lies in the center of the endosperm and consists of 2 elongated, plano-convex cotyledons and a cylindrical hypocotyl. The cells of the embryo contain protein granules of varying shape up to  $8\mu$  in diameter and fixed oil. Three pterome bundles extend through the mesophyll of each of the cotyledons. (See Fig. 429.)

Transverse section of *Plantago indica* (*P. arenaria*) seed similarly cut, show a somewhat similar structure but the palisade cells of the endosperm are up to  $52.5\mu$  in height.

Transverse sections of *P. ovata* seed cut through the central region are reniform in outline and exhibit a spermoderm, endosperm and embryo. The *spermoderm* shows (1) an *outer epidermis* of colorless cells with a thin, irregular cuticle,

the outer and radial walls lined toward the lumen with hardened stratified mucilage which swells and breaks down when sections are irrigated with water, the lumen occasionally containing starch granules, (2) a *pigment layer* of thin-walled, flattened, rectangular cells with dark brown contents. Directly beneath the spermoderm lies the *endosperm* composed of irregularly-shaped reserve parenchyma cells with walls of reserve cellulose, the lumina with a protoplasmic network enclosing vacuoles which contain fixed oil globules and protein.

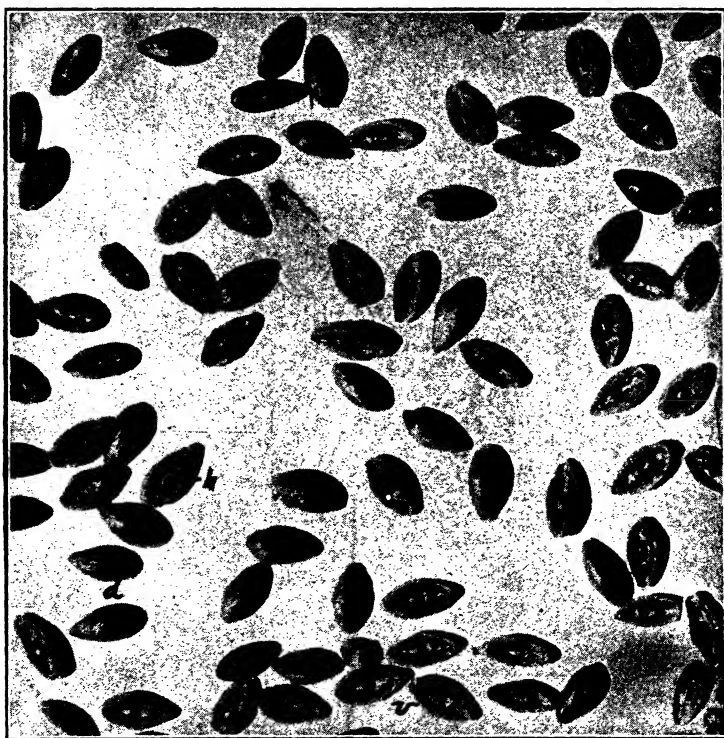


FIG. 428.—Blonde Psyllium seed yielded by *Plantago ovata*. Forsk., *d*, dorsal side; *v*, ventral side; *h*, hilum.  $\times 3$ .

(3) The *embryo* occupies most of the thickness of the section along the median line and is covered by an epidermis beneath which occurs thin-walled parenchyma containing fixed oil and protein. Three plerome strands course through each of the 2 cotyledons. Surface sections of the epidermis of the seed coat show the cells to be polygonal in outline.

✓ *Test for Quality*.—This is a test to determine the mucilage-swelling factor of Psyllium seed. When 1 Gm. of *Plantago* Seed is placed in a 25 cc. graduated cylinder and tap water added to the 20 cc. mark, the cylinder shaken at intervals during 24 hours at the expiration of which period the seeds are allowed to settle for 12 hours and the total volume occupied by the swollen seeds is noted, the seeds of *Plantago Psyllium* should occupy a volume not less than 14 cc., those of

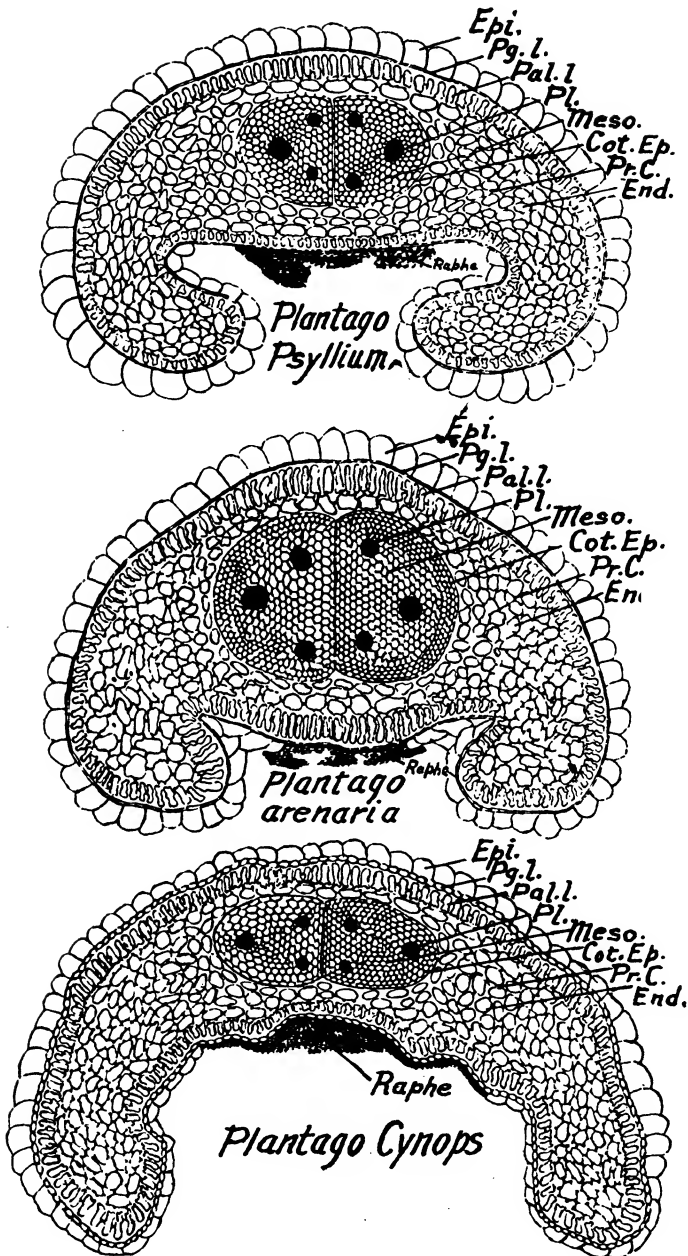


FIG. 429.—Transverse sections of seeds of *Plantago Psyllium*, *P. arenaria* and *P. Cynops*.  $\times 28$ . *Epi.*, epidermis and *Pg.l.*, pigment layer of seed coat; *Pal.l.*, palisade layer of endosperm; *Pl.*, plerome; *Meso.*, mesophyll and *Cot.Ep.*, Epidermis of cotyledon; *Pr.C.*, protoplasmic connections between cells of endosperm (*End.*). (From Youngken, *Am. Jour. Pharm. May*, 1934.)

*Plantago ovata* not less than 10 cc., and those of *Plantago indica* not less than 8 cc.

**Constituents.**—*Mucilage*, proteins, fixed oil, pentosans and galactans.

**Uses.**—Demulcent, laxative and emollient. The mucilage is employed as a cosmetic and in the stiffening of fabrics.

**Average Dose.**—7.5 Gm. (2 drachms).

**Adulterants.**—The chief adulterants found in the official *Psyllium* seeds have been foreign seeds including those of the *Cruciferae*, fruits of the *Gramineae*,

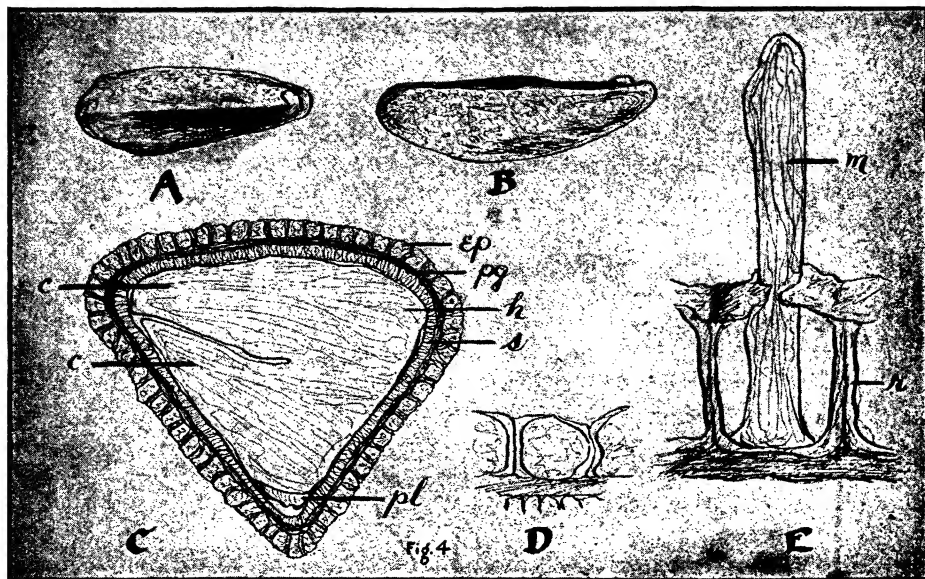


FIG. 430.—Fruit of *Lallelantia Royleana* Benth., a substitute for *Psyllium*. A, ventral surfaces; B, dorsal convex surface and portion of one of the ventral sides.  $\times 10$ . C, transverse section, showing epidermis (*Ep*) and pigment layer (*pg*) of pericarp, seed coat (*s*), cotyledons (*c*) and hypocotyl (*h*) of embryo, and placenta (*pl*). D, a more magnified view of a portion of the epidermis and subjacent tissue in a cross section of the dry fruit. Note mucilage in epidermal cell and the radial walls with middle lamellae. E, view of the outer portion of the cross section of the fruit directly after irrigation of mount of section of dry fruit with water, *m*, mucilage; *r*, peltate structure formed of radial and outer walls of adjacent epidermal cells. (From Youngken, *Jour. A.Ph.A.* 23 (1934), 399.)

tiny snail shells with sharp edges and membranous fragments of pyxes. French *Psyllium* from *P. indica* has been adulterated with torrefied seed of *Plantago lanceolata* and has also contained small amounts of *P. Cynops* seed.

**Substitutes.**—1. *German Psyllium Seed* yielded by *Plantago lanceolata* L. This seed also known as *English Plantain seed* is hemianatropous, oval to elliptical to oblong-ovate, glossy, light brown to dark brown, usually of both colors in commercial samples and no doubt representing different stages of maturity of the seed, from 2 to 2.5 mm. in length and from 1 to 1.2 mm. in breadth, concave-convex, with a broad, longitudinal, yellowish-brown area extending the length of the center of the upper surface and a deep excavation on the lower surface in the center of the base of which is an oval dark hilum from which in some seeds a raphe extends to one end.

When soaked in water the seed coat swells and becomes enveloped with a thin mucilage, not as viscous as in the case of that of Spanish or French Psyllium seed. Its mucilage is slightly acid to litmus. Its mucilage-swelling factor varies from 3.5 to 4.

2. Fruits (nutlets) of *Lallemantia Royleana* Benth. (Fam. *Labiatae*), an annual herb native to India and Iran, have been marketed as "Black Psyllium Seed."

When examined under a lens the nutlets are oblong-ovate, dull black to dark brown (immature fruit) with a light brown edge; when examined over a surface illuminated from below, with a dorsal convex surface and two plane or slightly concave ventral surfaces, the latter separated by a longitudinal ridge which extends to a cream-colored, elevated, saddle-shaped hilum at the narrow end; 3 to 3.5 mm. long and 1 to 1.2 mm. wide; internally the cut surface showing a narrow black pericarp and a large gray to bluish gray oily seed; odor indistinct; taste sweet and mucilaginous upon mastication. When 1 Gm. of the entire fruits was placed in a 50-cc. graduated cylinder, water added to the 50-cc. mark and the contents agitated at intervals during 24 hours, at the expiration of which time the total volume occupied by the swollen fruits was noted, the final reading showed the swollen fruits occupied a volume up to the 40-cc. mark. In 48 hours the volume occupied varied from 47 to 50 cc. The fruits, enveloped in mucilage, tended to cohere.

When entire dried fruits are examined in water under the compound microscope, the epidermis swells, the outer walls burst, liberating numerous finger-like processes of mucilage which later coalesce, forming a bluish-tinged mucilage which tends to adhere tenaciously to the fruits. Within 24 hours after a fruit has been macerating in water, the mucilaginous exudate adherent on its outer surface occupied an area of at least six times that of the fruit included within it. As noted in the sections, so also in the entire fruit, the radial walls together with portions of the broken outer walls of the epidermal cells appeared as long-stemmed goblets whose terminal cups frequently showed jagged margins. The mucilage at the end of this period appeared as irregular, interrupted, radiating strings.

#### RUBIACEÆ (MADDER FAMILY)

Herbs (*Galium* or *Cleavers*, *Mitchella* or *Partridge Berry*, etc.), shrubs (*Cephalanthus* or Button-bush, *Cephaelis* or *Ipecac*, etc.), or trees (*Cinchona* and *Remijia* species) with fibrous roots, sometimes, as in *Cephaelis Ipecacuanha*, annularly enlarged. Roots, stems and to a less extent leaves rich in varied alkaloids, some of medicinal value. Leaves opposite, entire, stipulate and interpetiolate. Inflorescence a raceme of dichesial cymes occasionally condensing to scorpioids. Flowers perfect, often dimorphic, pentamerous or tetramerous; sepals five (*Cinchona*, etc.) but four in *Galium*, small, green, subtended with other flowers by one or two or more enlarged petaloid bracts; petals five (*Cinchona*, etc.) to four in *Galium*, stellate, varying from shallow-rotate to elongate-tubular or funnel-shaped with stellate limbs; stamens five to four, epipetalous; pistil



nearly always bicarpellate, rarely of five to four carpels; ovary inferior, two-celled with central placentation; style either distinct with knob-shaped stigmas or style elongate, filiform, ending in bilobed stigmas. Fruit varied, a capsule in *Cinchona*, a berry in *Coffee*, a drupe, or frequently, as in *Galium*, dry and splitting into nutlets; seeds albuminous, each with a curved embryo.

#### CINCHONA N.F. (CINCHONA)

**Synonyms.**—*Cinchona Bark*, *Peruvian Bark*, *Jesuits' Bark*; *Fr. Quinquina*; *Ger. China*, *Chinarinde*, *Peruvianische Rinde*.

Yellow *Cinchona* = Yellow Bark, Yellow Peruvian Bark, Cartagena Bark, Calisaya Bark, Ledger Bark.

Red *Cinchona* = Red Bark, Red Peruvian Bark, St. Ann's Bark.

**History.**—An account of the early history of the use of *Cinchona* bark was reported by the botanist de Jussieu who visited Loxa in 1739 and learned of a Jesuit missionary having been attacked by malaria and who was cured by cinchona bark administered to him by an Indian medicine man of a neighboring village. According to legend, the Spanish corregidor of Loxa, Don Juan Lopez de Canizares, was claimed to have been cured of the same malady through the administration of this bark by another Indian medicine man in 1630. Don Lopez, in 1638, upon learning of the illness from tertian fever of the Countess of Chinchon, wife of the Viceroy of Peru, sent a packet of powdered cinchona bark to Dr. Juan de Vega, the physician treating the Countess. The Countess recovered and is stated to have brought back supplies of the bark to Spain. According to A. W. Haggis (*Bul. History of Medicine*, vol. 10, 1941), commenting on the official diary of the Count of Chinchon found by Miss I. A. Wright in the Sevillian *Archivo Generale de Indias*, the absence of any mention of the remedy or of any serious illness of the Countess in the Diary of the Count of Chinchon strongly suggests that the romantic story of the cure of the Countess by *Cinchona* is no more than a fable, also that she never returned to Spain but died at Cartagena, Colombia, Jan. 14, 1641 and so could not have brought the remedy to Europe. The Jesuit fathers are said to have introduced the bark into Italy about the same time. It was quickly adopted by the physicians of Spain, Italy and France, but was not introduced into England until about 1665 and then as a proprietary article called "The excellent powder known by the name of Jesuit's powder." In 1679, this secret remedy was purchased from its owner, Dr. Robert Talbor, by Louis XIV who, after Talbor's death, ordered the publication of his method of cure. The published formula revealed *Cinchona* as the chief ingredient. From this time on *Cinchona* became an article of commerce. It appeared in the London Pharmacopœia in 1677 under the title of "*Cortex Peruanus*" and was introduced into the United States Pharmacopœia of 1820, being recognized in every subsequent revision of this work until 1940, when it was deleted and later admitted to the National Formulary VII and VIII.

**Botanical Origin.**—*Cinchona succirubra* Pavon et Klotzsch or its hybrids (Red *Cinchona*) or *Cinchona Ledgeriana* (Howard) Moens et Trimen, *Cinchona*



FIG. 431.—*Cinchona Calisaya*. 1. Branch with leaves and flowers. 2. Corolla laid open. 3. Calyx and pistil. 4. Fruit. 5. 6. Seeds. 7. Mature leaf. (After Bentley and Trimen.)

*Calisaya* Weddell, and hybrids of these with other species of *Cinchona* (Yellow Cinchona or Calisaya Bark).

**Part Used.**—The dried bark of the stem or of the root.

**Standard of Assay.**—Not less than 5 per cent. of the alkaloids of Cinchona.

**Limit of Impurities.**—2 per cent. of foreign organic matter and 2 per cent. of acid-insoluble ash.

**Habitat.**—South America on the eastern slope of the Andes and western Cordilleras chain from 10° north latitude to 20° south latitude and from 3000 to about 9500 feet above the sea level.

**Plants.**—Evergreen trees attaining a height of 24 m. and having a trunk diameter of up to .6 m. at the base. The leaves are entire, opposite, coriaceous, elliptical or elliptical-lanceolate, petiolate and show lateral interpetiolar stipules. The flowers are pentamerous, tubular, and cymose. The fruits are septicidally dehiscent capsules, opening from the base upward and containing winged seeds.

**Production and Commerce.**—The Cinchona trees flourish in their wild state within forests of the Andes mountains of South America extending through Peru, Bolivia, Ecuador, New Granada, Venezuela and Colombia. They are also cultivated on a large scale in the Dutch and Anglo-Dutch plantations of Java, in the British government plantations of India and more recently on plantations in various of the South American countries and in Guatemala. The methods of collecting the bark vary in these several districts. In South America the usual practice employed is to fell the tree during the rainy season, strip the bark from it and dry it either in the open or over a fire in huts. The bark which is stripped from the trunk is usually deprived of its cork and pressed under weights during drying constituting the “flat bark” or “*quina tabla*”; that stripped from the branches curls during the drying process and is known as “*quina canuto*” or “*quilled bark*.” In Java and India the methods employed are uprooting and coppicing. Uprooting of the tree takes place when it has reached the age of about 12 years and the bark is stripped from both the roots and the stem. In *coppicing*, the trunk is cut through above the ground, the bark stripped from the felled portion, and the trunk left to coppice or form adventitious shoots, one or two of which are alone permitted to grow. After the shoots have attained the necessary age, their bark is stripped. This forms, after drying, fine long quills known as “*druggists’ quills*.” Collection of the bark invariably takes place during the rainy season when the bark is separated more readily from the wood.

Until World War II, the Cinchona barks purchased by firms in the United States came from plants cultivated in Java and India and from trees growing wild in South America. During the war the Board of Economic Warfare of the U. S. government sent botanists to the South American Republics to find new sources of Cinchona bark and revive the Cinchona-bark industry. They found large areas of *Cinchona pitayensis* Wedd. in Colombia and Ecuador whose bark

when analyzed yielded averagely about 3 per cent of quinine, and certain strains up to 6.5 per cent. Since that discovery large amounts of this bark have been gathered for quinine manufacture, some of which has been extracted in the field by a new portable apparatus. The commercial types of bark imported are druggist's quills, broken quills and chips. The quills usually arrive in cases, the

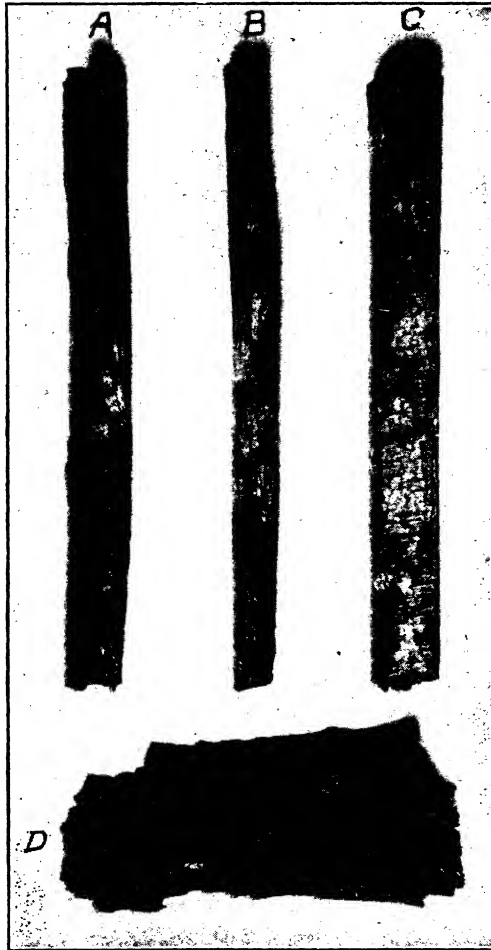


FIG. 432.—Cinchona barks. A and B, Red Cinchona; C, Yellow Cinchona; D, Tambla bark,  $\times \frac{1}{2}$ .

other grades in bags and bundles. Java Cinchona which, until World War II, constituted the greater bulk of bark imported was usually shipped here through Amsterdam, Rotterdam and London. Indian Cinchona prior to the recent war came direct from India or through London. South American Cinchona comes direct from Guayaquil, Ecuador, from La Paz, Bolivia and from Cartagena, Colombia, and from Peru. At the present writing it is the principal kind of Cinchona arriving in this country. During 1945, there were imported into this country 7,317,999 lbs. of Cinchona and quinine from Colombia, Ecuador, Peru,

Bolivia and Guatemala. Some supplies in 1947 arrived from Netherland Indies and British Malaya.

Red Cinchona is yielded by *C. succirubra*, a native of Ecuador, and its hybrids. Yellow Cinchona is yielded by *C. Ledgeriana*, and *C. Calisaya*, both natives of Southern Peru and Bolivia, and hybrids of these species with other species of *Cinchona*.

Pale Cinchona, also called "pale bark," "crown bark" and "Loxa bark" is obtained from *C. officinalis*, a native of Ecuador and Peru and recently found

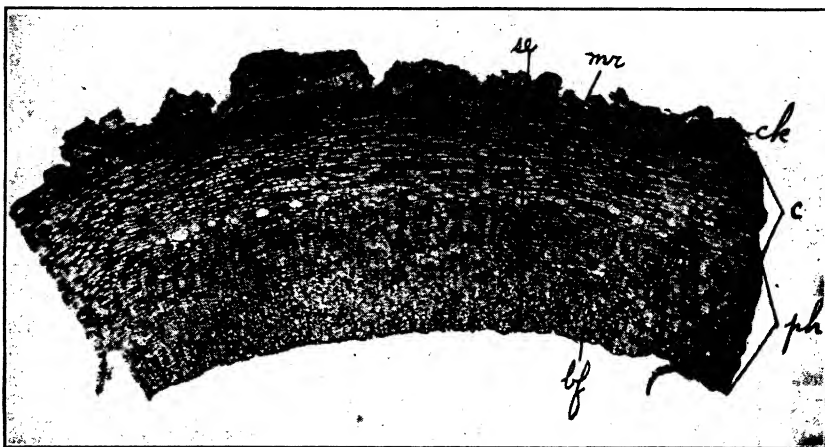


FIG. 433.—Transverse section of *Cinchona Calisaya* bark showing cork (*ck*); cortex (*c*); phloem (*ph*); bast fibers (*bf*); medullary ray (*mr*); secretory latex cell (*sc*). Photomicrograph  $\times 15$ .

widely distributed from western Venezuela through the eastern Andes of Colombia, Ecuador, Peru and Bolivia. It yields 1 to 4 per cent. of total alkaloids of which from one-half to two-thirds represents quinine. It is a source of quinine.

*Cinchona pitayensis* Wedd., a native of Colombia and Ecuador, possesses a yellowish-brown bark which resembles that of *C. officinalis* except that its edges roll in more tightly. It yields from 3 to 6.5 per cent of quinine.

**Description of Yellow Cinchona.**—In quills, flat pieces, chips, broken pieces, or curved pieces of variable length and from 3 to 10 mm. in thickness; outer surface of stem bark rough, grayish-brown to moderate yellowish-brown, with numerous intersecting transverse and longitudinal fissures, having nearly vertical sides, and usually with patches of lighter colored foliaceous lichens with their brownish-black apothecia appearing as small spots (stem bark); inner surface moderate brown to dusky yellowish-orange and striate; outer surface of root bark, rough, reddish-brown, scaly, fissured and wrinkled; inner surface light moderate brown to reddish-brown, finely striated; fracture granular in outer portion, finely splintery in inner portion; odor slightly aromatic; taste very bitter and somewhat astringent.

**Histology.**—The following microscopic characteristics may be observed in two of the Yellow Cinchona barks:

**Cinchona Calisaya var. Micrantha**

Secretory latex sacs in cortex.

Stone cells absent.

Phloem patches cone shaped.

Medullary-rays broad and wedge shaped.

Bast fibers comparatively small and less numerous.

**Cinchona Calisaya var. lancifolia**

No secretory latex sacs in cortex.

Stone cells in cortex.

Phloem patches elongated and narrow.

Medullary-rays narrow and elongate.

Bast fibers comparatively large and more numerous.

**Description of Red Cinchona.**—In quills, or flat pieces of variable length; bark from 2 to 4 mm. in thickness, or in small broken fragments or in transversely curved pieces from 3 to 7 mm. in thickness; externally brown, brownish-gray, or reddish-brown, more or less rough from reddish, warty protuberances and with *transverse fissures which are rarely numerous or much intersected, and having their sides sloping* and with occasional patches of foliaceous lichens (stem bark); inner surface dusky yellowish orange to reddish-brown, distinctly striate; that of root bark frequently fissured; fracture short and granular in the outer bark, shortly and rather coarsely splintery in the inner bark of the stem or finely fibrous in root bark; odor slight; taste very bitter and astringent.

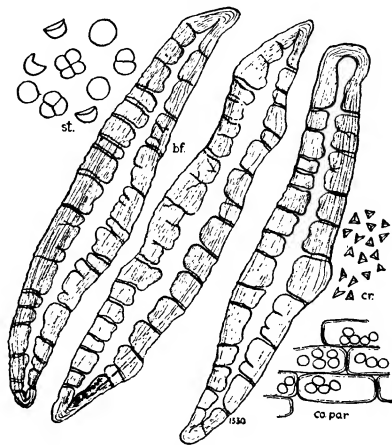


FIG. 434.—Powdered Cinchona. *st.*, starch grains; *bf*, bast fibers; *cr.*, micro-crystals; *co par*, cortical parenchyma. (Drawing by Izzo.)

**Histology.**—The chief diagnostic microscopical features of pure Red Cinchona stem bark are: The presence of an interrupted row of large, ovate, secretory laticiferous ducts up to  $120\mu$  in diameter at the junction of the cortex with the phloem, the presence of large, spindle-shaped, lamellated bast fibers arranged singly or in radial rows or groups within the phloem, the deep reddish-brown color of the walls of the parenchyma and medullary-ray cells most of which contain starch, some, sphenoidal micro-crystals.

The most striking diagnostic elements of all the Cinchona barks are the bast fibers. These appear like huge, elongated stone cells, when examined in longitudinal sections which have first been cleared with weak alcoholic solution of ammonia, in order to remove pigments from adjacent cells. They vary in length from  $300$  to  $1350\mu$  and in diameter from  $30$  to  $135\mu$ , possess yellowish, strongly lignified and lamellated walls and prominent pores, the latter frequently simulating the pore canals of stone cells. The medullary rays are usually 1- to 3-cells in width.

The cells of the cortex and medullary rays for the most part contain starch grains. Scattered here and there grayish-black cells will be noted. These contain very minute sphenoidal micro-crystals. Numerous cells contain reddish-brown to yellowish brown or orange amorphous masses.

Scrapings of the bark mounted in water show the starch grains to be simple or 2- to 5-compound. The individual grains are spheroidal or plano-convex and usually from 3 to  $10\mu$ , rarely up to  $21\mu$  in diameter.

Sections mounted in solution of gold chloride show the alkaloids occur mainly in the cells of the cortex.

**Powdered Cinchona.**—Light brown to moderate yellowish brown; bast fibers spindle-shaped, yellowish, from 300 to  $1350\mu$  in length and up to  $135\mu$  in width and with thick, lamellated, strongly lignified, porous walls having numerous simple or branched pores; starch grains simple or 2- to 5-compound, the individual grains spheroidal or plano-convex, usually from 3 to  $10\mu$  in diameter, but occasionally up to  $21\mu$  in diameter; numerous minute sphenoidal microcrystals; cork and parenchyma fragments yellowish orange to reddish-brown.

**Modified Grahe's Test for Identification of a True Cinchona Bark.**—Heat about 0.5 Gm. of ground Cinchona in the bottom of a dry test tube; purplish-red or carmine red vapors arise which condense as a distillate in purplish-red to orange drops on the walls of the upper part of the test tube. The distillate is soluble in diluted alcohol.

**Microchemic Test for Alkaloids.**—Mount a small quantity of powdered cinchona in a 2 per cent. solution of NaOH in 50 per cent. alcohol and apply cover slip. Heat gently, replacing the evaporated alcohol with water. Cool. Single rods and stellate groups of rods of the free alkaloids are visible under the microscope.

**Constituents.**—A number of alkaloids (about 6 to 7 per cent.), the most important being *quinine*, *quinidine*, *cinchonine* and *cinchonidine*; cinchotannic acid, quinic acid, cinchona red, etc. The alkaloids occur in combination with the organic acids.

*Quinine* ( $C_{20}H_{24}N_2O_2$ ) occurs as a white, microcrystalline, odorless powder which is only slightly soluble in water but very soluble in alcohol, the solutions of the latter being laevorotatory. It forms crystallizable salts with acids. A solution in dilute sulfuric acid shows a vivid blue fluorescence. It has an intensely bitter and persistent taste.

*Quinidine* is isomeric with quinine. It occurs in acicular white crystals or as a white powder, and crystallizes from alcohol in monoclinic prisms. It resembles quinine in many other properties but its solutions are dextrorotatory.

*Cinchonine* ( $C_{10}H_{22}N_2O$ ) is found as the sulfate in the mother liquors from which quinine sulfate has been crystallized. It crystallizes from alcohol in rhombic prisms, is sparingly soluble in water and more soluble in alcohol. Its solutions are dextrorotatory.

*Cinchonidine* is an isomeride of cinchonine. It crystallizes in large prisms, is sparingly soluble in water and more soluble in alcohol.

**Uses.**—Cinchona is used as a simple bitter, tonic, antimalarial and antipyretic, usually in the form of its preparations or alkaloids.

**Average Dose.**—1 Gm. (15 grains).

**Preparations.**—Compound Cinchona Tincture, N.F., 4 cc. (1 fl. dr.); Cinchona Alkaloids Elixir, N.F. (from alkaloids), 8 cc.

**Adulterants and Substitutes.**—(1) Cuprea bark is obtained from *Remijia pedunculata* Flückiger and *R. Purdieana* Triana, plants growing in the U.S. of Colombia. This has a copper color and is more compact and heavy than Cinchona. It is characterized microscopically by the presence of numerous

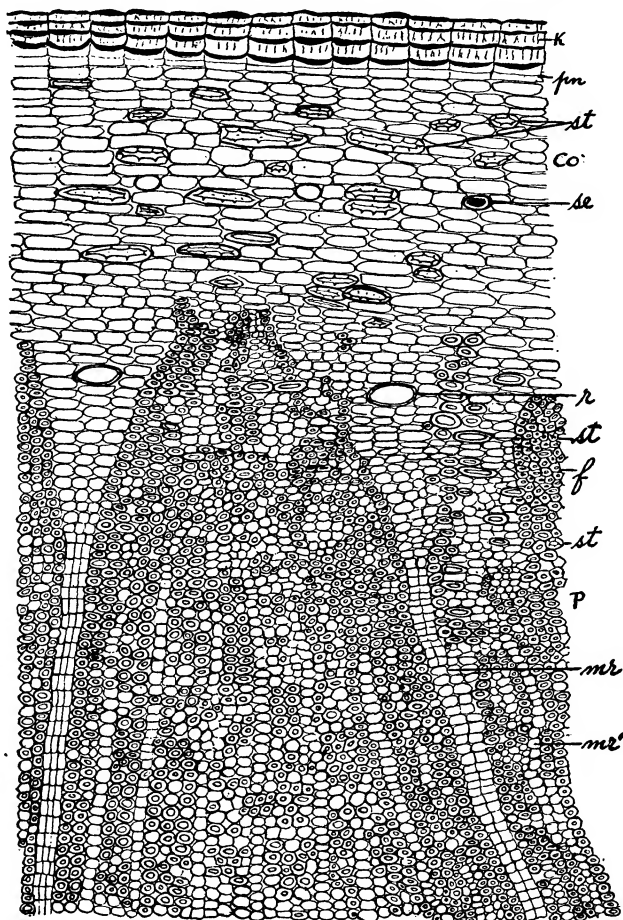


FIG. 435.—*Remijia pedunculata* bark. Cross section.  $\times 45$ . This is one of the cuprea barks which possesses a high quinidine content and which represents one of the chief sources of quinidine. It is also a source of quinine. K, cork; pn, phellogen; st, stone cells; se, secretory cells with latex-like content; co, cortex; r, reservoirs; P, phloem; f, fibers; mr', primary phloem ray; mr, secondary phloem ray.

stone cells in cortex and phloem. (2) Loxa bark, from *Cinchona officinalis*, a native of Ecuador. This occurs in thin quills, fissured transversely, otherwise smooth and yields up to 4 per cent. of alkaloids. The medullary rays in this bark are quite narrow. Cuprea bark from *R. pedunculata* and Loxa bark contain quinine and quinidine. During World War II a race of *Remijia pedunculata* was found in northern Colombia whose bark produced up to 3 per cent of quinine. This Cuprea bark also contains the alkaloid *cupreine*. (3) Barks of various species of *Cascarilla*, etc. which are devoid of cinchona alkaloids.



## TOTAQUINE U.S.P. (TOTAQUINA)

**Definition.**—A mixture containing not less than 10 per cent of anhydrous quinine and not less than 70 per cent and not more than 80 per cent of total anhydrous crystallizable cinchona alkaloids, the remainder consisting substantially of diluents, preferably lactose, starch or sucrose.

**Description.**—An odorless or nearly odorless, white, grayish white or slightly yellowish white powder with a persistent bitter taste. It is almost insoluble in water and partly soluble in warm alcohol, chloroform and in ether. It is darkened by light.

**Storage.**—It must be preserved in well-closed, light-resistant containers.

**Use.**—Antiperiodic.

**Average Dose.**—0.6 Gm. (10 grains). **Preparations.**—Totaquine Capsules and Tablets, U.S.P.

## QUININE N.F. (QUININA)

Quinine ( $C_{20}H_{24}O_2N_2 \cdot 3H_2O$ ) is an alkaloid usually obtained from *Cinchona*. It was isolated in its pure form by Pelletier and Caventou in 1820 from an impure cinchonine which had previously been separated from *Cinchona* by Gomez in 1811. Quinine is now being obtained from the barks of *Cinchona* spp. and from *Remijia pedunculata*.

**Tests.**—1 Gm. of Quinine is soluble in 0.8 cc. of alcohol and in 1560 cc. of water. When 5 cc. of a saturated aqueous solution of quinine or its salts is treated with 3 drops of bromine T.S. followed by the addition of 1 cc. of ammonia T.S., the solution acquires an emerald green color due to the formation of thalleioquin. A solution of quinine in dilute sulfuric acid shows a blue fluorescence.

Quinine and its salts should be stored in well-closed containers, protected from light.

**Uses.**—As an antimalarial, tonic and oxytocic, usually in the form of its more water-soluble salts; as a constituent of preparations.

**Average Dose.**—1 Gm. (15 grains).

**Preparation.**—Compound Hypophosphites Syrup, N.F., 8 cc. (2 fl. dr.).

**Quinine Poisoning.**—In Cinchonism or therapeutic overdoses of quinine, the usual symptoms are a feeling of fullness in the head, headache, ringing in the ears, deafness and mental dullness, and sometimes a weak pulse, gastrointestinal disturbances and impaired vision. Large poisonous doses lower blood pressure and depress the heart and respiration, causing extreme muscular weakness and collapse.

**Treatment.**—Give a bromide in large doses. Dilute hydrobromic acid has been found helpful for ringing in the ears or headache caused by quinine. Treat collapse.

## SALTS OF CINCHONA ALKALOIDS

**Quinine Ethylcarbonate, N.F.** (Quininæ Aethylcarbonas). Syn. Euquinine. The ethyl carbonate of an alkaloid obtained from cinchona. It occurs

in fine, white, soft needles or fleecy masses of needles and is practically tasteless. Tonic and antimalarial. Av. Dose, 1 Gm.

**Quinine Bisulfate, U.S.P.** (Quininæ Bisulfas). Syn. Quinine Acid Sulfate. The bisulfate of an alkaloid usually obtained from cinchona. Tonic, antimalarial and antipyretic. 1 Gm. dissolves in 10 cc. of water. Av. Dose, 1 Gm.

**Quinine Dihydrochloride, U.S.P.** (Quininæ Dihydrochloridum). The most freely soluble in water of all the official salts of quinine and frequently preferred for intravenous injections. 1 Gm. is soluble in about 0.6 cc. of water. Tonic, antimalarial and antipyretic. Av. Dose, 1 Gm. Preparation.—Quinine Dihydrochloride Ampuls, N.F. Av. Dose, 0.5 Gm. of Quinine Dihydrochloride.

**Quinine and Urea Hydrochloride, N.F.** (Quininæ et Ureæ Hydrochloridum). It is the most suitable of all the salts of quinine for hypodermic injection owing to its neutral reaction and its solubility. It is used in severe types of malaria; as a sclerosing agent in the treatment of varicose veins, in 10 per cent. solution, by hypodermic injection into veins; in 1 to 3 per cent. solutions by hypodermic injection, as a local anesthetic in sciatic rheumatism and minor operations; etc. Preparation.—Quinine and Urea Hydrochloride Ampuls, N.F. Av. Dose, 0.5 Gm. of Quinine and Urea Hydrochloride.

**Quinine Hydrochloride, U.S.P.** (Quininæ Hydrochloridum). Syn. Muriate of Quinine. Tonic, Antipyretic, Antimalarial. Av. Dose, Oral; 0.6 Gm. (10 gr.); Intramuscular, 0.2 Gm. (3 grains). Preparations. In U.S.P., Quinine and Urethane Injection. In N.F., Iron, Quinine and Strychnine Elixir, 4 cc. (1 fl. dr.); Compound Glycerophosphates Elixir, 8 cc. (2 fl. dr.).

**Quinine Hydrobromide, N.F.** (Quininæ Hydrobromidum). This drug is used in Graves' disease and is stated to be the most efficient of the official quinine salts in pneumonia. Av. Dose, 0.3 Gm. (5 grains).

**Quinine Phosphate, N.F.** (Quininæ Phosphas). Tonic, Antipyretic. Av. Dose, 0.3 Gm. (5 grains). Preparation.—Iron, Quinine and Strychnine Phosphates Elixir, N.F., 4 cc. (1 fl. dr.).

**Quinine Salicylate, N.F.** (Quininæ Salicylas). Tonic and mild analgesic in rheumatism and muscular pain. Av. Dose, 0.3 Gm. (5 grains).

**Quinine Sulfate, U.S.P.** (Quininæ Sulfas)  $(C_{20}H_{24}N_2O_2)_2 \cdot H_2SO_4 \cdot 2H_2O$ . The sulfate of an alkaloid obtained from cinchona. Antimalarial, oxytocic, antipyretic and tonic. Av. Dose, 0.6 Gm. (10 grains). Preparations.—Quinine Sulfate Tablets, U.S.P., Cinchona Alkaloids Elixir, N.F., 8 cc. (2 fl. dr.).

**Quinidine Sulfate, U.S.P.** (Quinidinæ Sulfas)  $(C_{20}H_{24}N_2O_2)_2 \cdot H_2SO_4 \cdot 2H_2O$ . The sulfate of the alkaloid quinidine obtained from various species of *Cinchona* and their hybrids and from *Remijia pedunculata* Flückiger (Fam. *Rubiaceæ*), or prepared from quinine. It occurs in odorless, fine, needle-like crystals having a very bitter taste. It darkens on exposure to light and should be stored in well-closed, light-proof containers. It is used chiefly in auricular fibrillation and irregular heart rhythms, but also as an antimalarial for persons having an idiosyncrasy to quinine. Av. Dose, 0.2 Gm. (3 grains). Preparation.—Quinidine Sulfate Tablets, U.S.P.

**Cinchonidine Sulfate, N.F.** (Cinchonidinæ Sulfas)  $C_{19}H_{22}ON_2 \cdot H_2SO_4 \cdot 3H_2O$ .

The sulfate of an alkaloid obtained from cinchona. Antimalarial. Av. Dose, 0.15 Gm. ( $2\frac{1}{2}$  grains). Preparation.—Cinchona Alkaloids Elixir, N.F.

**Cinchonine Sulfate, N.F.** (Cinchoninæ Sulfas)  $C_{19}H_{22}ON_2 \cdot H_2SO_4 \cdot 2H_2O$ . The sulfate of an alkaloid obtained from cinchona. Antimalarial and tonic. Av. Dose, 0.15 Gm. ( $2\frac{1}{2}$  grains). Preparation, Cinchona Alkaloids Elixir, N.F.

**Allied Products.**—**Ethylhydrocupreine Hydrochloride, N.F.** (Aethylhydrocupreinae Hydrochloridum). Syn. Optochin Hydrochloride. A synthetic derivative of cupreine, an alkaloid found in the bark of *Remijia pedunculata* (Fam. *Rubiaceæ*). It may also be prepared synthetically from quinine. It occurs as a white to faintly yellowish-white, odorless powder with bitter taste. 1 Gm. is soluble in about 2 cc. of  $H_2O$ . It is used in 1 to 2 per cent. solutions, locally, in eye infections, especially for those caused by the pneumococcus.

**Pamaquine Naphthoate, N.F.** (Pamaquinæ Naphthoas)  $C_{42}H_{45}N_3O_7$ . Syn.—Plasmochin, *Aminoquin Naphthoate*. It occurs as a yellow to orange-yellow, almost tasteless powder insoluble in water and producing numbness to the tongue. It is used as a prophylactic in malaria, as it kills the gametocytes, and combined with quinine in the treatment of malaria. Av. dose, 20 mg. ( $\frac{1}{3}$  gr.)

**Quinacrine Hydrochloride, U.S.P.** (Quinacrinæ Hydrochloridum). Syn. *Mepacrine Hydrochloride*; Atabrine Di-Hydrochloride, Chinacrin Dihydrochloride.  $C_{23}H_{30}ClN_3O \cdot 2HCl \cdot 2H_2O$ . It occurs as a bright yellow, crystalline powder, without odor and with a bitter taste. Antimalarial. Used to destroy the trophozoites or asexual forms of *Plasmodium malariae* and *P. vivax*, also as prophylactic in addition to quinine. It partially destroys the gametocytes or sexual forms of certain malarial organisms. Av. Dose, 0.1 Gm. ( $1\frac{1}{2}$  grains). Preparation.—Quinacrine Hydrochloride Tablets, U.S.P.

#### IPECAC U.S.P. (IPECACUANHA)

**Synonyms.**—Ipecac Root, *Ipecacuanhæ radix*, *P.I.*; Poaya; *Fr.* Racine brésilienne; *Ger.* Brechwurzel, Ruhrwurzel.

**Botanical Origin.**—(1) *Cephaelis Ipecacuanha* (Brotero) A. Richard (*Uragoga Ipecacuanha* Baillon) and (2) *Cephaelis acuminata* Karsten (*Uragoga granatensis* Baillon).

**Part Used.**—The dried rhizome and roots.

**Standard of Assay.**—Not less than 2 per cent. of the ether-soluble alkaloids of Ipecac.

**Limit of Impurities.**—5 per cent. of its overground stems and 2 per cent. of other foreign organic matter.

**Habitat.**—(1) Brazil, (2) United States of Colombia, in forests.

**Plants.**—*Cephaelis Ipecacuanha* (*Evea Ipecacuanha* Standley), commonly known as Rio or Brazilian Ipecac, is a low, straggling shrub whose underground portion consists of a slender rhizome bearing annulated wiry roots and slender smooth roots. The rhizome arches upward and becomes continuous with a short, green, aerial stem bearing a few opposite, petiolate, stipulate, entire, obovate leaves. The flowers are small, white and capitate, occurring in the

leaf axils, the corolla being infundibuliform. The fruit is a cluster of dark purple berries, each containing 2 plano-convex seeds.

*Cephaelis acuminata* somewhat resembles the Brazilian species but has a root with less pronounced annulations.

**Production and Commerce.**—Rio or Brazilian Ipecac grows in rich, moist forest soil in Brazil and Bolivia. It is particularly abundant in the provinces of Matto-Grosso and Minas Geraes, Brazil. In the latter province it is cultivated by setting out rhizome cuttings. The roots together with portions of the rhizome, are gathered from wild and cultivated plants from January to late March by natives who then dry them in the sun and pack them in bales made of hide (serons). These bales are stored and later purchased by traders who ship them to Rio de Janeiro, Pernambuco or Montevideo for export. Some

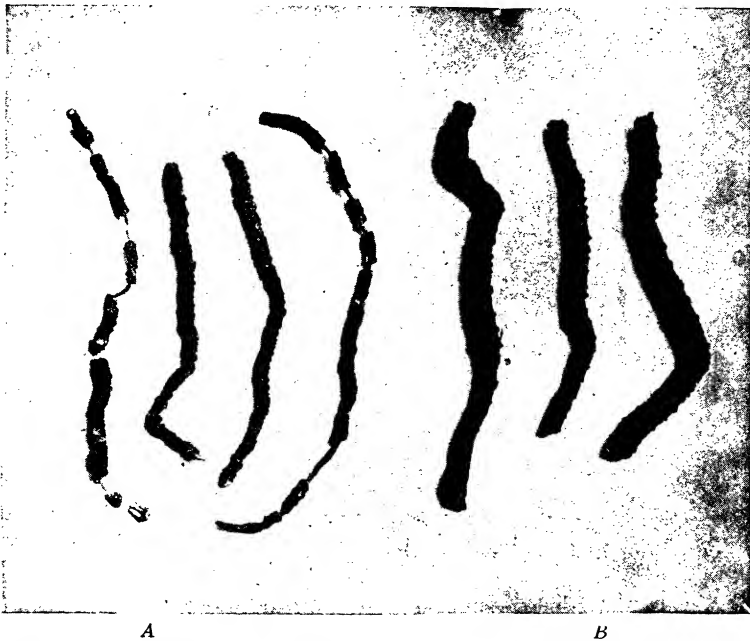


FIG. 436.—A, Rio Ipecac; B, Cartagena Ipecac,  $\times \frac{3}{8}$ . (Photograph by Stoneback.)

Rio Ipecac is also grown in the Straits Settlement (Yohore or Indian Ipecac) but none of this reaches the United States.

Cartagena or Nicaragua Ipecac grows in forests of United States of Colombia and in Nicaragua. It is exported to this country in bales from Cartagena and Savanilla, Colombia, from Nicaragua and through Panama.

**Description.**—Rio or Brazilian Ipecac occurs as cylindrical pieces of roots of variable length mixed with nearly smooth, grayish-brown rhizomes, the latter up to about 3 mm. thick; roots reddish-brown to dark brown, either closely annulated or smooth, from 1 to 5 mm. in diameter, simple or branched, usually with transverse fissures having vertical sides which often extend to the wood; bark of annulated root about two-thirds the diameter of the root, bark of the

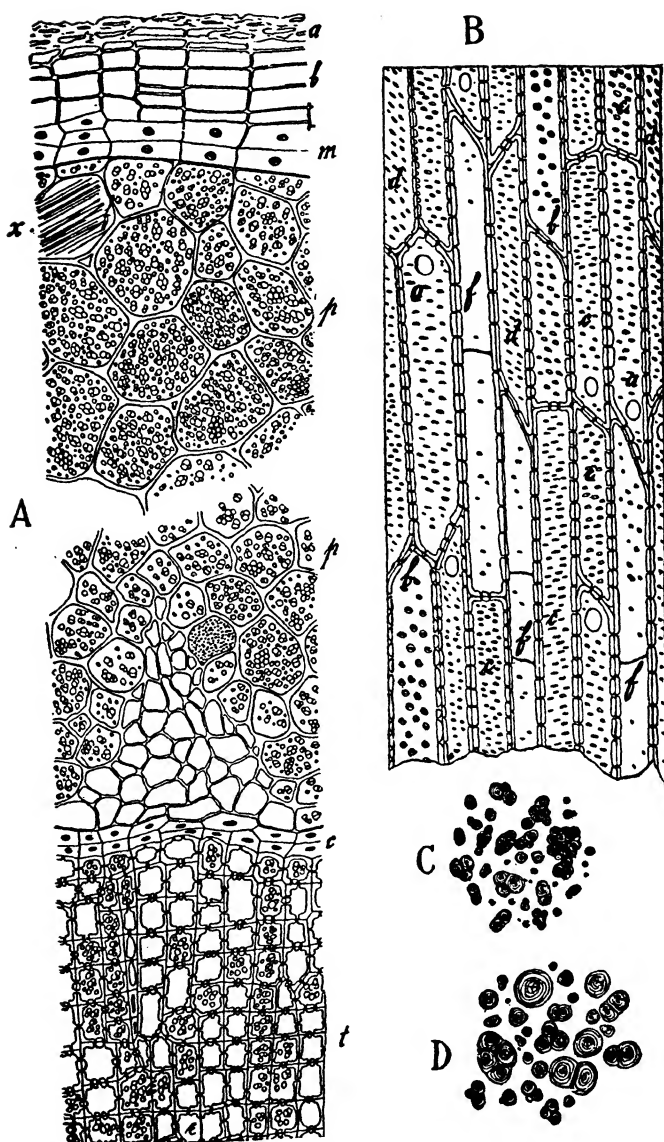


FIG. 437.—Rio Ipecac. A, Transverse section of annulated root *a*, outer layers of old cork; *b*, young cork; *m*, phellogen; secondary cortex composed of parenchyma (*p*) containing starch and raphides (*x*); *c*, cambium, directly outside of which will be noted a conical phloem of clear looking cells representing phloem parenchyma and sieve tubes; *t*, tracheary tissue of xylem. B, Longitudinal-radial section of a portion of the wood showing tracheæ with circular openings and pitted walls (*a*), tracheids with bordered pores (*b*), with simple linear pores (*c*) and oblique linear pores (*d*); transition tracheids (*e*); tracheids with delicate pores (*f*). C, Starch grains of Rio Ipecac. D, Starch grains of Cartagena Ipecac. (After Schneider, from "Pharmacognosy" by Gathercoal and Wirth, Lea and Febiger, publishers.)

smooth root thin, about one-ninth of the entire diameter; fracture of bark short, readily separable from the tough, fibrous wood; odor slight; taste bitter, nauseous and acrid. The rhizome, which is up to about 10 cm. in length and 3 mm. in thickness, is finely longitudinally wrinkled and shows a few elliptical scars and a pith, the latter about one-sixth its diameter.

Cartagena or Nicaragua Ipecac differs from Rio Ipecac macroscopically by the following points: It is thicker, being up to 6.5 mm. in diameter. Its color is gray, grayish-brown, or reddish-brown and its annulations are less numerous. There are 2 sub-varieties of Cartagena Ipecac viz., the grayish-brown and reddish-brown. At present the supplies of Ipecac coming from Nicaragua are of the reddish-brown kind. The reddish-brown variety is frequently beset with numerous transverse ridges bearing light colored abrasions.

**Histology.**—Transverse sections of Ipecac root show the following microscopical peculiarities passing from periphery toward the center:

1. *Cork* of several layers of tabular cork cells, some with granular masses covering the tangential cells.
2. *Cork cambium* of meristematic cells.
3. *Cortex*, a broad zone of irregularly rounded cells, most of which contain starch and active principles, a few, raphides of calcium oxalate.
4. *Phloem*, a narrow zone of more or less cone-shaped phloem patches composed of sieve tubes and phloem cells, the patches separated from each other by wedge-shaped strands of parenchymatous cells.
5. *Cambium* of meristematic cells.
6. *Xylem*, taking up the remainder of the root in the sections and composed chiefly of porous tracheids, less numerous peculiar tracheæ and a few lignified wood fibers. Coursing radially through the xylem are modified prosenchymatous medullary-rays, the cells containing starch grains up to  $15\mu$  in diameter in Rio Ipecac and up to  $22\mu$  in the Cartagena variety.

Longitudinal sections show the tracheids to be of two kinds, the one showing bordered pores, the other, slit-like simple pores. The tracheæ show openings slightly beneath their ends.

Transverse sections of Ipecac rhizome differ from the root mainly by exhibiting a narrower xylem, a pericycle with stone cells, and a central pith.

**Powdered Drug.**—Pale brown, weak yellow or light olive gray; fragments of thin-walled parenchyma loaded with starch; numerous simple or 2- to 8-compound starch grains, the individual grains spheroidal, plano-convex or angular in outline, up to  $15\mu$  (Rio Ipecac) or  $22\mu$  in diameter (Cartagena Ipecac); fragments of tracheids and tracheæ with bordered pore or simple pore markings; raphides of calcium oxalate up to  $56\mu$  in length; fragments of cork with polygonal shaped, grayish to brownish walled cells, as seen in surface view. When the powder contains stem admixture it shows in addition, elongated porous stone cells with lignified walls.

**Constituents.**—The alkaloids: *emetine* ( $C_{28}H_{37}O_8N_2 \cdot OCH_3$ ), *cephaeline* ( $C_{28}H_{37}O_8N_2 \cdot OH$ ), kryptonine and psychotrine; a glycoside termed ipecacuanhin, ipecacuanhic acid, starch, calcium oxalate, etc.

**Emetine**, the expectorant, emetic, diaphoretic and germicide alkaloid, is a white powder forming crystalline salts with acids. It forms a dirty green solution with Froehde's reagent. It is less emetic and more expectorant in action than cephaeline. Its official hydrochloride is soluble in water and alcohol.

**Cephaeline**, an emetic and expectorant alkaloid (which is more emetic than expectorant in action), is soluble in alkaline solution, insoluble in water, quite soluble in alcohol and chloroform and forms colorless needles on crystallization.

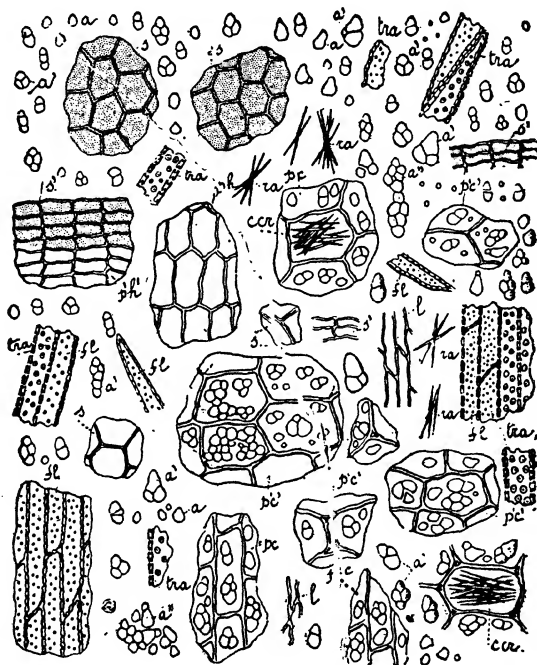


FIG. 438.—Powdered Ipecacuanha Root (*Cephaelis Ipecacuanha*). *a, a', a''*, Starch grains, simple and compound. *cor*, Cells with raphides of calcium oxalate. *fl*, Tracheids with simple pores; *l*, Leptome. *pc, p'c*, Cortical parenchyma in longitudinal and transverse section. *ph, p'h*, Phelloderm in surface view and section. *ra*, Raphides of calcium oxalate. *s, s'*, Cork in surface view and profile. *tra*, Tracheids with bordered pores,  $\times 210$ . (From Sayre after Greenish and Collin.)

It dissolves in Froehde's reagent giving a purple color which changes to deep blue upon the addition of hydrochloric acid.

**Uses.**—Nauseating expectorant in the dry stage of respiratory inflammations, diaphoretic and emetic. *Emetine hydrochloride* U.S.P. is used in the treatment of amœbic dysentery, because of its toxic action on *Entamœba histolytica*, and in pyorrhea alveolaris.

**Average Dose.**—Emetic, 0.5 Gm. ( $7\frac{1}{2}$  grains).

**Preparations.**—In U.S.P., Ipecac Fluide Extract, Expectorant (unof. dose), 0.06 cc. (1 minim), Emetic, 0.5 cc. (8 minims); Ipecac Syrup, Expectorant (unof. dose), 0.75 cc. (12 minims), Emetic, &c. (2 fl. dr.). In N.F., Ipecac and

Opium Powder (*Dover's Powder*) 0.3 Gm. (5 grains); Ipecac and Opium Syrup, 4 cc. (1 fl. dr.); Ipecac and Opium Tincture (from Fldext.), 0.5 cc. (8 minims); Ipecac Tincture, 0.6 cc. (10 minims); Aloin, Strychnine, Belladonna and Ipecac Pills, 1 pill.

**Adulterants and Substitutes:** (1) *Ipecac Stems*.—These may be distinguished from the rhizome by the presence of opposite leaf scars in the terminal portion, by the presence of stone cells in the pericycle and by possessing chloroplastids. They contain the same alkaloids as the rhizome and roots but in smaller amounts.

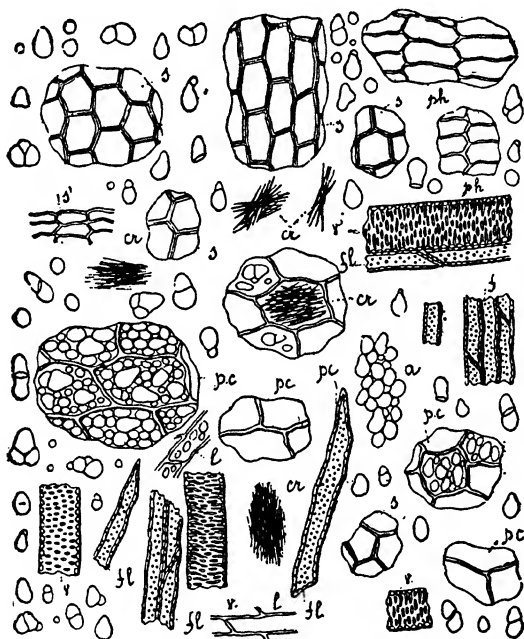


FIG. 439.—Powdered Undulated Ipecac (*Richardsonia scabra*),  $\times 210$ . a, starch grains; cr, raphides of calcium oxalate; fl, pitted wood fibers; l, bast; pc, cortical parenchyma; ph, phelloderm; s, s', cork in surface view and section; v, pitted tracheae. (From Sayre after Greenish and Collin.)

(2) *Undulated Ipecac*.—The root of *Richardia indica* L. (*Richardsonia scabra* St. Hilaire) (Fam. *Rubiaceae*), indigenous to Brazil, occurs in tortuous pieces like Ipecac, but its upper portion is cylindrical, the crown showing several slender stem bases. It is less fissured and annulated than Ipecac, its wood is distinctly porous, due to the presence of pitted tracheae, its bark frequently violet-colored, its single starch grains attain a diameter of up to  $22.5\mu$  and its xylem medullary-rays are 1 cell in width.

(3) *Greater Striated Ipecac*.—The root of *Psychotria emetica* L. (Fam. *Rubiaceae*) resembles somewhat Cartagena Ipecac from which it may be distinguished in cross sections by its violet-colored bark and absence of starch.

(4) *Lesser Striated Ipecac*.—The root of *Manettia ignita* Schumann, also called *Black Ipecac* and *False Ipecac*, occasionally occurs as an admixture



in the authentic article. It appears as short pieces of gray-brown color and cylindrical to narrowly fusiform shape, 2 to 3 cm. long and 2 to 3 mm. in thickness. These are often irregularly constricted, cross sections under the microscope, showing a starchy, violet colored bark and a yellow, porous wood.

(5) *White Ipecac.*—The root of *Ionidium Ipecacuanha* St. Hil. (Fam. *Violaceæ*) is devoid of annulations, considerably branched, of grayish-white or yellow color. Transverse sections exhibit a narrow, dark bark with stone cells but no starch and a broad yellowish and porous wood.

(6) Roots of *Heteropteris pauciflora* A. Juss. (Fam. *Malpigiaceæ*) from Brazil which are devoid of starch and possess rosette aggregates of calcium oxalate, stone cells, and brown pigment cells. (7) Roots of a *Polygala* from Central America.

**Emetine Hydrochloride U.S.P.** (Emetinæ Hydrochloridum) is a hydrated hydrochloride of an alkaloid obtained from ipecac or prepared synthetically by methylation of cephaeline. It occurs as a white or pale yellowish, odorless, crystalline powder which is freely soluble in water and alcohol. It is affected by light and should be stored in light-resistant containers.

**Uses.**—As an amebicide in amœbic dysentery, amœbic abscess of the liver and in pyorrhea alveolaris.

**Average Dose.**—Daily, by intramuscular injection, 60 mg. (1 grain).

**Preparation.**—Emetine Hydrochloride Injection U.S.P.

#### GAMBIR N.F. (GAMBIR)

**Synonyms.**—*Pale Catechu*, Terra Japonica, Gambier; *Ger.* Gambir Catechu; *Fr.* Gambir cubique.

**Botanical Origin.**—*Uncaria Gambir* (Hunter) Roxburg [*Ourouparia Gambir* (Hunter) Baillon].

**Part Used.**—The dried aqueous extract prepared from the leaves and twigs.

**Standards.**—Not less than 70 per cent. of water-soluble extractive and not less than 60 per cent. of alcohol-soluble extractive; not more than 0.5 per cent. of acid-insoluble ash.

**Habitat.**—Malay Archipelago.

**Plant.**—A perennial, woody, climbing shrub having more or less angular stems somewhat thickened at the nodes, opposite, entire, oblong-ovate, petiolate, acuminate leaves, spherical axillary clusters of small pinkish flowers and capsular fruits. The seeds are very small, brownish and tailed at either end.

**Production and Commerce.**—The plant is cultivated chiefly in the Dutch East Indies and in Johore and Pahang of the Straits Settlements. The extract is prepared by natives and Chinese from cultivated shrubs. The young leafy stems are cut off and transported to the factory where the leaves and young twigs are placed in a large cast iron or copper pan and boiled for about 3 hours in water, during which time they are continually bruised and stirred with long, four pronged wooden forks. The residue is removed, pressed, washed and the washings run into the pan. The decoction is then strained, poured into small wooden tubs, evaporated until it has reached a syrupy consistence and allowed to cool. During the cooling process, the extract is induced to crystallize by

working a wooden stick up and down in the liquor until a mass of soft clay consistency is formed. This pasty mass is poured into trays with removable wooden sides and cloth bottoms. The wooden sides are provided with surface saw cuts. When the mass has hardened sufficiently, the wooden sides of the tray are removed and the mass is cut into cubes by means of a string drawn through the marks of the saw cuts. The Gambir cubes are then dried in the sun. It is then packed in wooden cases for export. Most of the world's supply of Gambir comes from Singapore.

**Description.**—In approximately cubical or rectangular masses from 20 to 30 mm. in diameter or in irregularly shaped pieces, externally dark reddish-gray to light brown, dull and porous; friable; internally weak brown to weak yellowish-orange; inodorous; taste very astringent and bitterish.

**Identity Test.**—1 Gm. of Gambir is macerated with 50 cc. of distilled water for 1 hour, and filtered, and the filtrate separated into 2 portions. Upon the addition of diluted ferric chloride T.S. to one portion of the filtrate, an intense green color is produced. The addition of cupric sulfate T.S. to the second portion of the filtrate does not produce a precipitate.

**Powdered Gambir.**—Light brown to moderate yellowish brown; taste bitterish and very astringent. It consists chiefly of masses of interlacing acicular crystals; a few simple and compound starch grains of various shapes, from 5 to 30 $\mu$  in diameter, and very few epidermal fragments and thick-walled, wavy, non-glandular hairs up to 350 $\mu$  in length.

**Constituents.**—From 25 to 50 per cent. of *catechutannic acid*, up to 33 per cent. of *catechin*; catechu red, gambir-fluorescin, etc.

**Uses.**—In medicine, as an astringent. Most of the product is employed by the dyeing and tanning industries.

**Average Dose.**—0.5 Gm. (7½ grains).

**Preparation.**—Compound Gambir Tincture, 2 cc. (30 minims).

#### COFFEA TOSTA (COFFEE)

**Synonyms.**—Roasted Coffee; *Fr.* Café; *Ger.* Kaffee.

**Botanical Origin.**—(1) *Coffea arabica* Linné, (2) *Coffea liberica* Hiern., and (3) *Coffea robusta* (L.) Linden.

**Part Used.**—The dried ripe seed, deprived of most of the seed coat and roasted until a dark brown color and a characteristic aroma are developed.

**Purity Rubric.**—Not less than 1 per cent. of caffeine, not less than 3 per cent. nor more than 5 per cent. of total ash and not less than 10 per cent. of fat (N.F. V).

**Habitat.**—Africa. (1) Abyssinia. (2) Liberia.

**Plants.**—Evergreen trees having opposite, oblong-ovate, coriaceous, glabrous and shining, acuminate leaves, axillary clusters of fragrant, white, tubular flowers and red or purple berry fruits about the size of cherries. Each flower consists of a 5-toothed calyx, a tubular, 5-lobed corolla, 5 stamens, a 2-celled ovary and a bifid style. The fruit consists of a 2-celled pericarp surrounding 2 plano-convex seeds, each with a longitudinal groove on its plane surface, both

facing each other by their plane surfaces, each being surrounded by a thin membranous endocarp and fiber zone called "parchment."



FIG. 440.—*Coffea arabica* Linné as grown in Florida.

**Production and Commerce.**—The coffee plants are extensively cultivated in Arabia, Java, Brazil, Venezuela, Ecuador, Peru, Colombia, Central America, West Indies, India and Hawaii. They are grown from seeds and yield mature

fruits in 2 or three years but generally require 5 years before yielding a good crop. The fruits are gathered when fully mature and prepared for the market either by the dry or wet methods. The former consists of spreading the fruits out on a floor and exposing them to the drying action of the sun. The dried pulp, parchment and silverskin are subsequently removed by threshing or pounding in mortars or by special machines, and the seeds liberated. This method is employed mainly in Arabia which produces Mocha coffee.

The wet method is the more modern and that now more generally employed.

It consists of placing the fruits in a tank of water where they remain overnight. In this the ripe fruits sink and are drawn through pipes to a pulping machine where the fleshy portion is reduced to a pulp and the pulp and free seeds, enclosed in their parchment, conveyed to a second tank of water. Here they are stirred, the pulp being separated by washing and the seeds sinking to

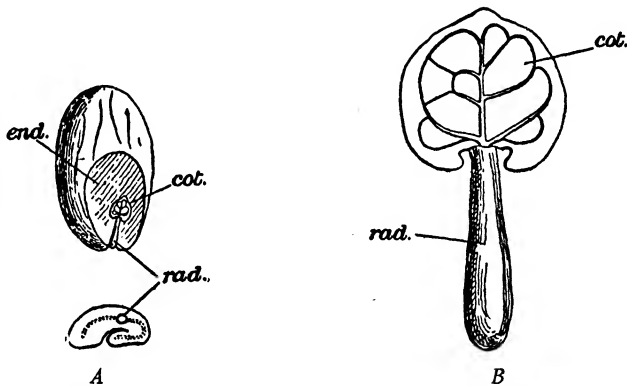


FIG. 441.—A, Diagram of coffee seed showing relative position of embryo, groove and perisperm. Cotyledons (*cot*) and radicle (*rad*) of embryo. B, Embryo of coffee seed showing one of the cotyledons (*cot*) and the radicle (*rad*). (Enlarged.) (After Greenish.)

the bottom. The parchment coverings are removed by subsequently allowing them to slightly ferment, by trampling the seeds, stirring and washing. The seeds are then dried in the sun or by artificial heat. They constitute what is known as "raw coffee." In this condition the seeds are yellowish or dull green, each with papery spermoderm ("silver skin") in the longitudinal cleft on the flat side. The seeds are now graded for roasting by passing them through sieves having large, medium and small apertures. They are then garbled to remove split or otherwise defective seeds and foreign matter. The seeds are imported in bags usually in the raw or unroasted condition.

Most of the coffee imported into this country is roasted here. The process of roasting requires considerable skill and care, lest some of the aroma be lost. It is this process which causes the coffee seeds to swell up and become altered in their constituents. During this process the fragrant substance coffeol, which gives to coffee its flavor and aroma, is developed. During this process, also, a portion of the caffeine is liberated from the caffeotannic acid.

About 80 per cent. of all the coffee produced at the present time comes from Brazil. The United States consumes over one-half of the world's supply of coffee. During 1947, this country imported 2,495,699,615 lbs. of raw coffee and 4,824,144 lbs. of roasted coffee.

**Description.**—Oval to ellipsoidal in outline, plane on one side, with a longitudinal groove showing traces of the papery seed coat, convex on the other, of variable size; dark brown; odor aromatic, characteristic; taste bitter.

**Histology.**—Coffee seeds may be prepared for sectioning by soaking overnight in water. The remains of the spermoderm (seed coat) may be picked out of the groove with a fine pair of forceps and examined separately. The seeds present for examination 3 regions, viz.: (1) spermoderm, (2) perisperm\* and (3) embryo.

The *spermoderm* consists of a layer of more or less obliterated parenchyma cells over which are scattered elongated, variously shaped, porous stone cells from  $100\mu$  to over  $1000\mu$  in length and up to  $135\mu$  in breadth. These occur singly or in small groups, the latter showing intercellular-air-spaces between the component elements.

The *perisperm* takes up the greater area of the seed and consists of an outer layer of more or less square shaped cells with thick cuticle and a broad inner zone of larger cells having knotty walls of reserve cellulose about  $10\mu$  in thickness and containing oil globules and aleurone grains. A few minute starch grains may only occasionally be found in some of the cells.

The *embryo* consists of a blunt radicle 3 to 4 mm. in length and 2 small heart-shaped cotyledons, each pinnately 3-nerved.

Chloral hydrate solution and a mixture of equal parts of ammonia water and peroxide of hydrogen, are valuable clearing agents, when roasted coffee is under examination.

**Ground Coffee.**—This should be cleared with either of the afore-mentioned reagents before examination. Coarser particles may be picked out

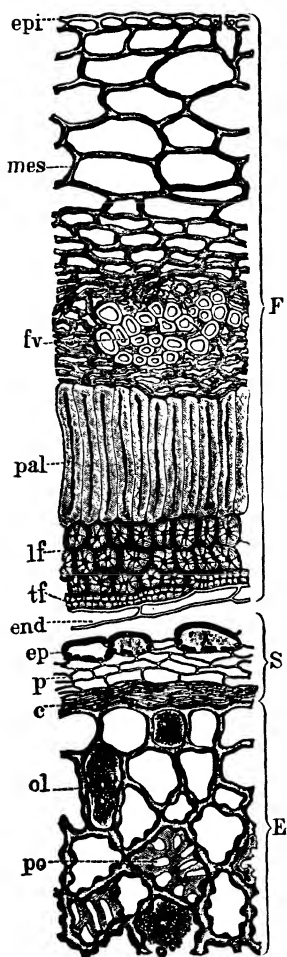


FIG. 442.—Coffee. Berry in cross section. F, pericarp: epi, epicarp; mes, mesocarp with fv bundle; pal, palisade cells with thick walls; lf, tf, crossing fibers; end, endocarp. S, spermoderm; E, perisperm: ol, oil droplets; po, porous wall.  $\times 160$ . (After Winton and Winton, "Structure and Composition of Foods," Vol. IV, J. Wiley and Sons, Inc.)

\* This region was formerly known to pharmacognosists as the *endosperm* but recent studies in the development of the ovule show it to be formed from the nucellus, hence representing *perisperm* tissue.

and sectioned after soaking in water or clearing solution, and paper fragments of the seed coat may be picked out with a forceps and mounted separately. The characteristic elements to be noted are the numerous fragments of seed coat with variously shaped, porous stone cells arranged singly or in small groups:

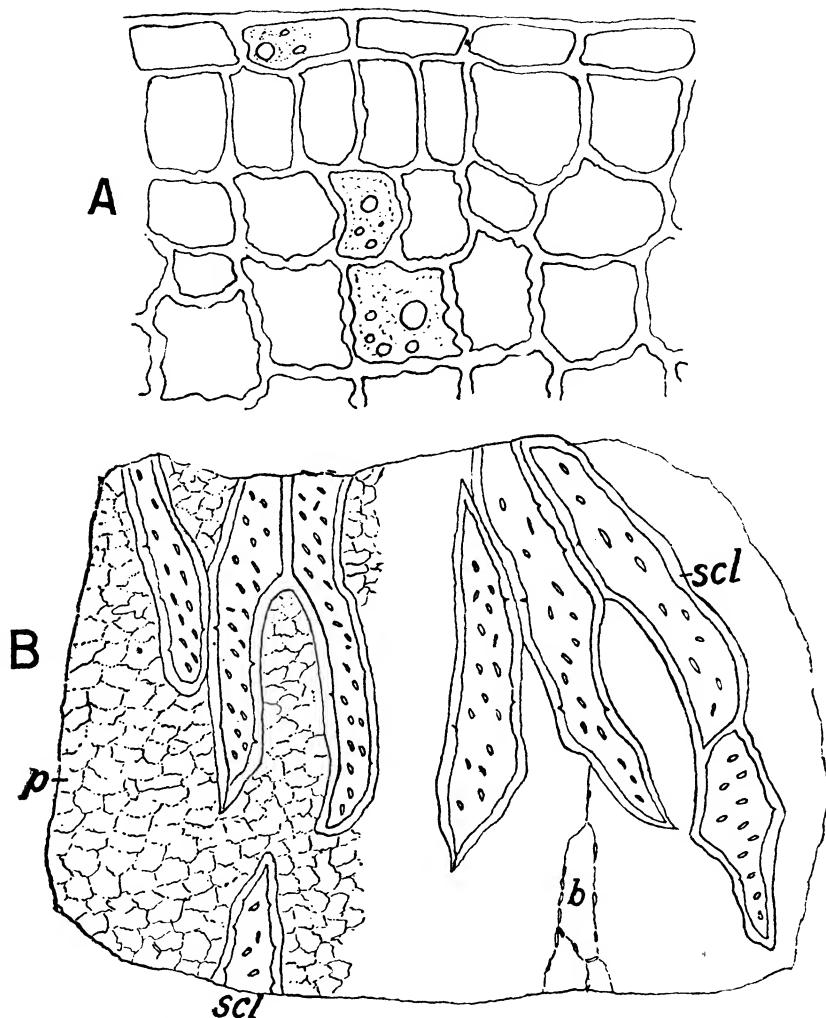


FIG. 443.—Coffee. A, Portion of outer perisperm of seed showing perisperm cells with reserve cellulose walls which, while nearly uniform in outer layer or two, become unevenly thickened and beaded farther inward. B, Portion of seed coat removed from the groove of a coffee seed. Parenchyma cells (*p*); sclerenchyma cells with oblique pores (*scl*); cells with minutely beaded walls (*b*). (Partly diagrammatic.)

the knotty-thickened walled cells of the perisperm (walls about  $10\mu$  in width) with aleurone and oil contents; few spiral tracheæ.

**Constituents.**—*Coffeol*, *caffeine* (1 to 2 per cent.), 10 to 13 per cent. of fixed oil, from 2 to 5 per cent. of tannin; proteins, glucose, dextrin, etc.

**Uses.**—Roasted coffee is widely used in the preparation of a decoction that is employed as a stimulating beverage. Medicinally, a strong decoction is used in the treatment of poisoning by alkaloids and as a cerebral stimulant. A source of caffeine.

**Adulterants:** Whole roasted coffee has been adulterated with artificial coffee seeds made by moulding and roasting dough and also with roasted masses of pea hulls, ground cereal and molasses.

Ground roasted coffee has been adulterated with the following ground roasted materials:

1. *Chicory root (Cichorium Intybus)* identified by its short, pitted and reticulate tracheæ with short to moderately elongated pores, grotesquely shaped wood fibers, and numerous laticiferous vessels (usually less than  $10\mu$  broad). The tracheæ are from 25 to  $115\mu$  in breadth. (See Fig. 444.)

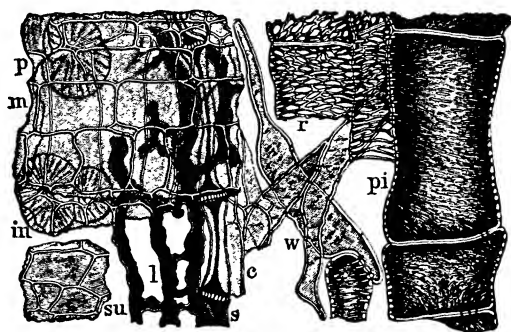


FIG. 444.—Chicory Root (*Cichorium Intybus* L.). *su*, cork in tangential section. Longitudinal radial section of alcohol material: *p*, phloem parenchyma with *in* sphaero-crystals of inulin; *m*, medullary ray; *s*, sieve tube; *c*, companion cell; *l*, laticiferous vessels. Macerated material: *r*, reticulate tracheæ; *pt*, pitted tracheæ; *w*, wood fibers and cells.  $\times 160$ . (After Winton and Winton, *Structure and Composition of Foods*, John Wiley & Sons, Inc.)

2. *Taraxacum root*, identified by its pitted and reticulate tracheæ, up to  $80\mu$  in width, with elongated pores along with its laticiferous vessels.

3. *Cereals and Cereal Products*, identified by their characteristic hairs, cross cells and starch grains. See pp. 165, 166.

4. *Coffee hulls*, identified by a layer of elongated, curved, palisade cells with yellowish contents and whose walls take a red color with safranin, the contents remaining yellow. (See Fig. 445.)

5. *Leguminous seeds*, including peas, beans, chick-peas, peanuts, carob beans, soja beans, coffee cassia, lupines, etc., characterized by fragments of leguminous palisade cells and starch grains.

6. *Acorn kernels*, characterized by distorted ellipsoidal or elongated starch grains, each with a prominent elongated hilum.

7. *Figs*, identified by fragments of mesocarp of receptacle containing abundant branching latex tubes up to  $50\mu$  in breadth, and rosette crystals of calcium oxalate, spiral and pitted vessels, by fragments of the epicarp with small thick-walled cells  $20\mu$  or less in diameter, arranged in radiate fashion around the circular bases of unicellular non-glandular hairs, that are frequently detached,

and by the minute akenes which are usually imbedded in the roasted pulp.

8. *Ivory nut* (*Phytalephas macrocarpa*) characterized by its large thick-walled endosperm cells with porous walls of reserve cellulose from 35 to 50 $\mu$  or more in thickness.

9. *Narcissus bulbs* (*Narcissus poeticus* and *N. pseudonarcissus*), which have elongated raphides of calcium oxalate that occur in long crystal cells and thin walled parenchyma containing swollen starch grains.

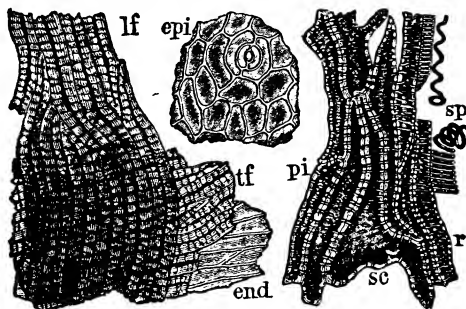


FIG. 445.—Coffee Hull. Elements of pericarp in surface view. *epi*, epicarp; *sc*, sclerenchyma cells; *pi*, pitted cells; *r*, reticulate vessels; *sp*, spiral vessels; *lf*, longitudinal and *tf*, transverse fibers; *end*, endocarp.  $\times 160$ . (After Winton and Winton, "Structure and Composition of Foods," J. Wiley & Sons, Inc.)

#### JOHIMBE (YOHIMBE)

The dried bark of *Corynanthe Johimbe* Schum., a tree native to the southern Cameroons, Gabon and French Congo of Africa.

**Description.**—In flattened or slightly quilled pieces, up to 100 or more cm. in length, up to 16 cm. in breadth and from 3 to 10 mm. in thickness; outer surface brown, fissured, and frequently showing patches of yellowish-green or greenish-gray lichens; inner surface smooth, brown; fracture of outer portion short, of inner portion fibrous to splintery-fibrous; the fractured surface yellowish-brown; inodorous; taste bitter.

**Constituents.**—From 0.5 to 6 per cent of alkaloids including *yohimbine* which crystallizes from dilute alcohol in colorless needles, *mesoyohimbine* and *yohimbine*; calcium oxalate, etc.

**Uses.**—As a source of the alkaloid *yohimbine*, the chief active principle; in domestic medicine of Africa as an aphrodisiac. *Yohimbine hydrochloride* and *yohimbine lactate* are used in *neuresthenic impotence*, in *arteriosclerosis* and *angina pectoris* in average doses of 5 mg. ( $\frac{1}{12}$  grain).

#### CAPRIFOLIACEÆ (HONEYSUCKLE FAMILY)

Shrubs or rarely herbs. Leaves entire, opposite, exstipulate or with delicate, attenuate or filiform stipules (*Viburnum Opulus*). Inflorescence varying from a raceme of shortened cymes to a capitulum. Flowers varying from regular and small (*Sambucus* or Elder, *Viburnum*, etc.) to increasingly large, slightly irregular and ultimately very irregular, in some Honeysuckles and in a few *Weigelas*



and allies; calyx pentamerous, superior; corolla superior, gamopetalous, limb pentafid, small in *Viburnum* and *Sambucus* to elongate, tubular or irregular infundibuliform in *Lonicera*s; stamens five, inserted on tube of corolla and alternating with corolla segments; filaments equal or didynamous (in irregular flowers); ovary inferior, rarely five- to three-celled, usually three- or frequently two-celled; style terminal. Fruit a berry (*Snowberry*) or drupe (*Viburnum*) from an inferior ovary, several celled, occasionally becoming one-celled with several to rarely one seed, or fruit a capsule (*Diervilla* or *Bush Honeysuckle* and *Weigela*). Seeds albuminous. Glandular hairs are common to most species. Scalariform tracheæ and wood prosenchyma with bordered pits are found in most genera. Calcium oxalate occurs in solitary prisms, or rosette aggregates, rarely as micro-crystals (*Sambucus*). Borke formation occurs in the axis of *Viburnum*.

#### SAMBUCUS (SAMBUCUS)

**Synonyms.**—Elder Flowers, American Elder, Sweet Elder; *Ger.* Holunderblüthen; *Fr.* Fleurs de sureau.

**Botanical Origin.**—(1) *Sambucus canadensis* Linné and (2) *Sambucus nigra* Linné.

**Part Used.**—The air-dried flower.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—(1) United States and lower Canada. (2) Europe.

**Plants.**—*Sambucus canadensis*, known as Common Elder or American Elder, is a shrub growing in moist soil, frequently on the border of meadows or swamps. Its stems attain a height of 4 m. and contain abundant white pith, the latter being employed for imbedding plant parts for sectioning purposes. Its leaves are imparipinnate with 5 to 11 oblong, glabrous leaflets, the lower ones being often 3-parted. The inflorescences are flat compound cymes. The flowers are small, white, each with 5 minute calyx lobes, and urn-shaped, 5-cleft gamopetalous corolla, 5 stamens and a tricarpellate pistil having 3 stigmas. The fruits are black-purple edible, berry-like drupes.

**Production and Commerce.**—Elder flowers are gathered from wild plants in June and July, separated from the peduncles and pedicels, by sifting, and carefully dried and preserved. Most of the drug has been imported from Europe largely through Hamburg, Budapest and Trieste.

**Description.**—Flowers small and shriveled, 2 to 3 mm. broad; calyx superior, 5-lobed; corolla weak yellowish-orange to moderate yellow, urn-shaped, 5-lobed, regular; stamens 5, epipetalous, each possessing a slender filament and yellow, oblong anther; pollen mostly rounded or ellipsoidal, occasionally tetrahedral, covered with finely punctate markings and showing 3 pores in the exosporium, from 15 to 25 $\mu$  in diameter; odor faintly sweet and aromatic, taste slightly bitter.

**Constituents.**—*Volatile oil*, *mucilage*, gum, resin, tannin, *bitter principle*, etc.

**Uses.**—Elder flowers are employed in the form of a tea as a diaphoretic and stimulant and in the preparation of elder-flower ointment and elder-flower water.

**Average Dose.**—4 Gm. (60 grains).

VIBURNUM PRUNIFOLIUM N.F. (VIBURNUM PRUNIFOLIUM)

**Synonyms.**—*Black Haw*, Viburnum, Stag-bush; *Ger.* Schneeballrinde; *Fr.* Écorce de boule de neige d'Amérique.



FIG. 446.—*Viburnum prunifolium* (Black Haw). Leaf and fruiting branch,  $\times \frac{1}{10}$ .

**Botanical Origin.**—(1) *Viburnum prunifolium* L. (Black Haw) and (2) *Viburnum rufidulum* Rafinesque (Southern Black Haw).

**Part Used.**—The dried bark of the root or stem.

**Purity Rubric.**—Not more than 7 per cent. of adhering wood, not more than 2 per cent. of other foreign organic matter and not more than 3 per cent. of acid-insoluble ash.

**Habitat.**—United States (1) from New York and Connecticut to Florida, west to Michigan, Texas, Arkansas and Missouri; (2) Virginia to Florida, west to Illinois, Missouri and Texas.

**Plants.**—*Viburnum prunifolium* is a shrub or small tree attaining a height of about 15 ft., leaves opposite, slenderly petiolate, glabrous, ovate with serr-

late margins; flowers white and arranged in sessile compound cymes; fruit an oval, bluish-black, sweet and edible drupe with a flat stone.

*Viburnum rufidulum* or Southern Black Haw (*Viburnum prunifolium* L. var. *ferrugineum* T. & G.) is a tree attaining a height of about 30 ft. with stout, rigid branches, small, obtuse, rusty-hairy winter buds and elliptic to obovate, usually obtuse and serrulate leaves, up to about 4 in. in length, the latter glabrous, shining and dark green on the upper surface, rusty-pubescent on the veins

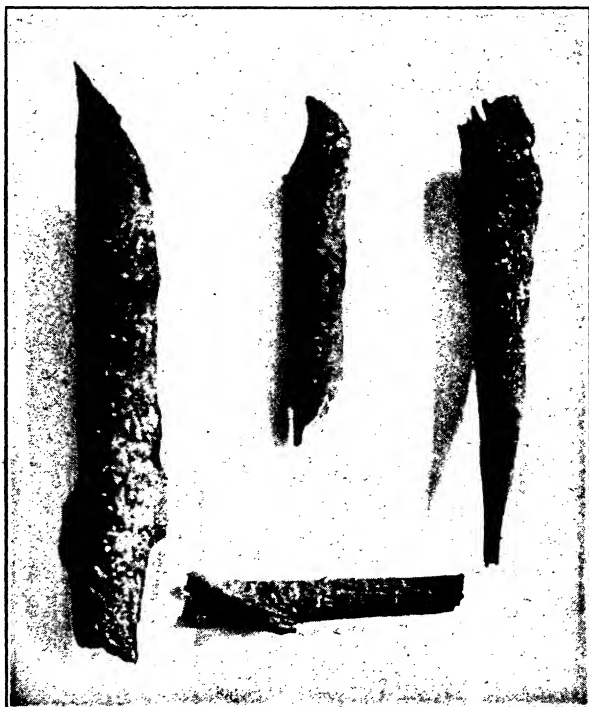


FIG. 447.—Root bark of *Viburnum Prunifolium*,  $\times \frac{1}{2}$ .

beneath, especially toward the base, and with usually narrow, winged, rusty-pubescent petioles up to  $\frac{1}{2}$  in. in length. The flowers are white and arranged in sessile compound cymes. The fruits are dark blue, ellipsoidal, glaucous drupes with a flat stone.

**Production and Commerce.**—Large quantities of Black Haw bark are gathered in North Carolina and Tennessee. While formerly abundant, the natural stands of *Viburnum prunifolium* are dwindling owing to the destruction of vast numbers of the trees by collectors in obtaining the root bark which was formerly alone officially recognized. For this reason the N.F. VII admitted the stem bark and the var. *ferrugineum* (*V. rufidulum* Raf.) which possess the same properties.

**Description.**—Root bark in irregular transversely curved pieces or quills, up to about 9 cm. in length, up to 2 cm. in width and from 0.5 to 3.5 mm. in

thickness. Outer surface brown or where the outer cork has scaled off, reddish-brown to yellowish-brown and irregularly longitudinally wrinkled; inner surface pale yellowish to brownish-red and frequently exhibiting light-colored streaks, longitudinally striated; fracture weak, brittle and uneven showing a grayish-brown to dark brown cork, a brownish-red bark and a whitish inner bark in which a number of light yellow groups of stone cells are discernible with the aid of a hand lens. **Stem bark** in transversely curved or quilled pieces up to 15 cm. in length and up to 6 mm. in thickness; outer surface of young bark grayish with raised, circular or oval lenticels; older bark brownish-gray to black (unrossed bark) or reddish-brown to olive-brown (rossed bark); inner surface paler, longitudinally striated; fracture short and uneven, showing scattered groups of stone cells in the light-colored inner bark; odor, upon ageing or moistening, mildly valerian-like, becoming more pronounced upon trituration with phosphoric acid; taste bitter and astringent.

**Histology of Root Bark.**—Transverse sections of the root bark present the following structure:

**Younger bark:**

1. *Cork*, an outer zone of variable thickness composed of somewhat lignified cork cells which are tangentially-elongated in cross sections and polygonal in surface sections, many of which possess orange or yellowish orange or brownish amorphous contents.

2. *Phellogen* of tangentially-elongated meristematic cells.

3. *Secondary cortex*, a relatively narrow zone of tangentially-elongated parenchyma cells, some of which contain orange or brownish amorphous masses, others tannin, oil globules and starch, others monoclinic prisms and rosette aggregates of calcium oxalate. Groups of stone cells with irregularly indented margins and isolated stone cells are scattered through this region. Rifts between parenchyma cells are present in some of the sections.

4. *Phloem*, a relatively broad zone consisting of a matrix of phloem parenchyma and sieve tubes separated into a number of oblong or curved phloem patches by medullary rays which, in cross sections, run nearly straight or curve and converge in groups. Their passage outward is frequently intercepted by tangentially placed groups of stone cells. The stone cell groups are numerous in this region and frequently deeply notched, the individual stone cells being strongly lignified with prominent pore canals and rounded to irregular lumen, the latter frequently containing reddish to brownish contents. Bast fibers are absent.

The medullary-rays are mostly 1 to 2 cells wide as observed in tangential-longitudinal sections and their cells contain either starch, tannin, orange brownish amorphous masses or calcium oxalate crystals.

Rosette aggregates of calcium oxalate occur in cells of the cortex, medullary rays and phloem and are up to  $54\mu$  in diameter. Monoclinic prisms of calcium oxalate also occur in these regions but considerably fewer than the rosettes, and up to  $25.2\mu$  in length. Numerous crystal fibers containing rosette aggregates of calcium oxalate occur in cortex and phloem.

Starch grains present in parenchyma cells of phloem and cortex and in medullary ray cells are simple and spheroidal to 2- to 3-compound, the individual grains being up to  $23\mu$  in diameter.

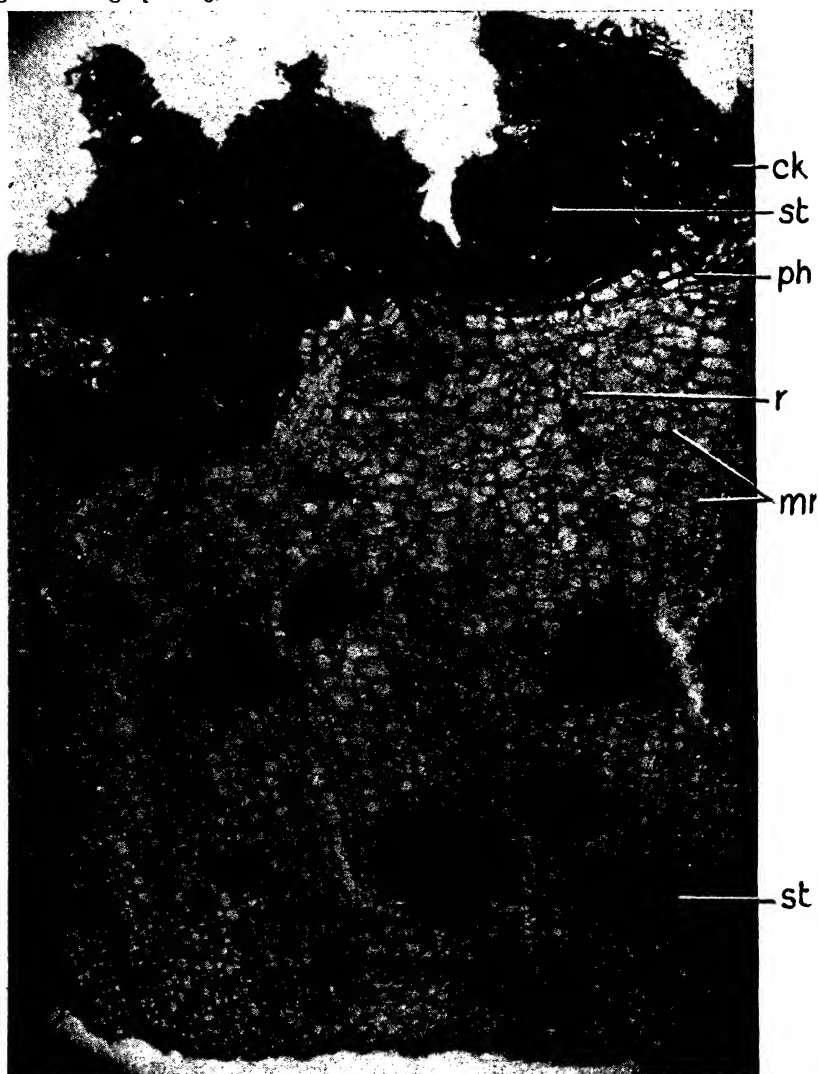


FIG. 448.—Photomicrograph of a transverse section of old root bark of *Viburnum prunifolium*,  $\times 50$ . *ck*, borke; *st*, groups of stone cells; *ph*, secondary phellogen; *mr*, phloem rays; *r*, rosette aggregate of calcium oxalate.

#### Older root bark:

As the bark thickens and grows older, *secondary phellogens* develop in the cortex and outer phloem cutting off cork on their outer faces. The tissues external to these perish and form the borke which gradually disintegrates and

sloughs off. Fig. 448 is that of a section of old bark which shows the results of this activity. The outer masses of stone cells are those originally present in the cortex or in outer phloem but now included in *bork*.

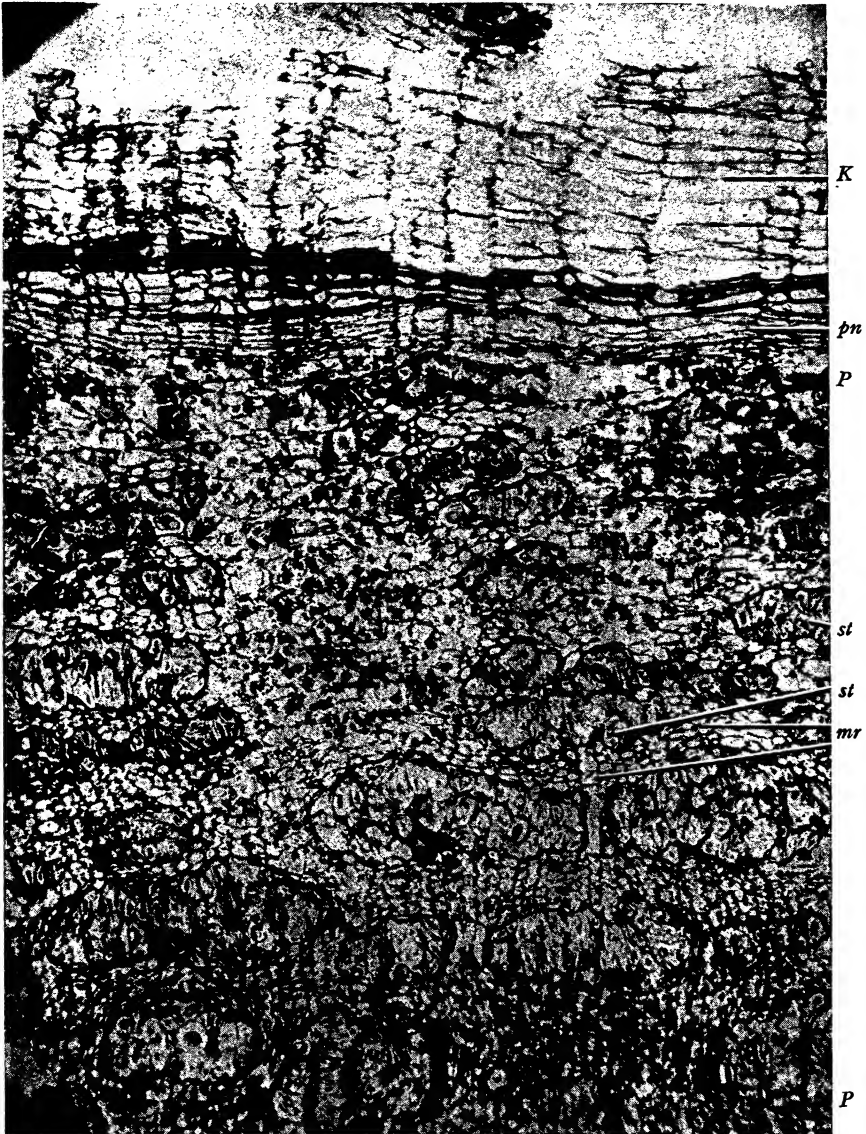


FIG. 449.—*Viburnum rufidulum* (Southern Black Haw). Root Bark. Photomicrograph of a transverse section,  $\times 50$  diam. K, cork; pn, phellogen; P-P, phloem; st, group of stone cells; mr, phloem medullary rays. The black objects in the parenchyma cells are calcium oxalate crystals.

**Histology of Stem Bark.**—Transverse sections of the stem bark of either *Viburnum prunifolium* or *V. rufidulum* present the following structural features:

1. *Epidermis* in very young bark, replaced by cork in older bark.
2. *Cork* of variable width and composed of usually tangentially-elongated cells with suberized to lignified walls and yellow, orange or brown amorphous contents.
3. *Phellogen*, consisting of tangentially-elongated meristematic cells.
4. *Cortex*, containing cortical parenchyma, the cells of which are mostly tangentially-elongated and contain starch grains, tannin, oil, orange to brownish amorphous masses, or calcium oxalate crystals. Scattered through this region are groups of stone cells and occasional isolated stone cells. Rifts or spaces of natural origin also occur in this region.
5. *Pericycle*, consisting of parenchyma similar to the cortex, in which are imbedded a few pericyclic fibers. The latter, when observed in longitudinal sections, possess irregular lumina and obtuse or rounded ends.
6. *Phloem* of variable width, consisting of sieve tissue, phloem parenchyma and phloem rays, the phloem parenchyma containing starch grains, rosette aggregates and monoclinic prisms of calcium oxalate, tannin, amorphous orange, yellow or olive brown masses and oil. The phloem rays vary from straight to slightly curved or wavy and, while mostly 1 to 2 cells in width, are up to 1 to 3 cells in width, as best determined from tangential-longitudinal sections through this region of the bark. Scattered through the phloem are numerous groups of stone cells. The margins of these groups are irregularly rounded, crenate, toothed and indented. Some of the phloem rays are intercepted in their outward course by groups of stone cells.

**Old Stem Bark.**—As the stems of these *Viburnums* grow older, secondary cork cambia originate successively in the cortex, pericycle and outer phloem forming *wavy borke areas* in these zones which contain groups of stone cells and, in the case of the pericyclic region, pericyclic fibers. In old stem bark, sloughing off of these borke areas occurs as far as the last secondary phellogen and cork is formed in the outer phloem by the remaining secondary phellogen, so that, in real old stem bark, the medullary rays (phloem rays) reach outward to the periderm.

**Powdered Drug.**—Light brown to moderate yellowish brown. Stone cells numerous, rounded or elongated, in groups or isolated, with thick, porous, lignified walls and with reddish to brownish lumina and up to  $260\mu$  in length; numerous fragments of lignified cork with brownish walls and polygonal in shape; calcium oxalate in rosette aggregates and monoclinic prisms up to  $57\mu$  in diameter or length; fragments composed of parenchyma cells containing starch grains or calcium oxalate in rosette aggregates or monoclinic prisms, oil globules or orange to olive brown colored amorphous masses; starch grains simple or 2- to 3-compound, the individual grains spheroidal, ovate, elliptical, pyriform or plano-convex, up to  $23\mu$  in diameter or length; few fragments having wood fibers with lignified walls, some with lumina of irregular width and with bordered pores.

**Constituents.**—A *glycoside* representing a *uterine sedative principle* (Evans, Harne, and Krantz (1942)); *volatile oil*, containing volatile organic acids; a

greenish-yellow resinous substance called by Krämer, *viburnin*; salicin, an *enzyme* which splits viburnin into valeric acid and glucose, free *valeric acid*, *resin*, tannin giving a greenish-black color with 1:100 solution of ferrous sulphate, starch, calcium oxalate, etc.

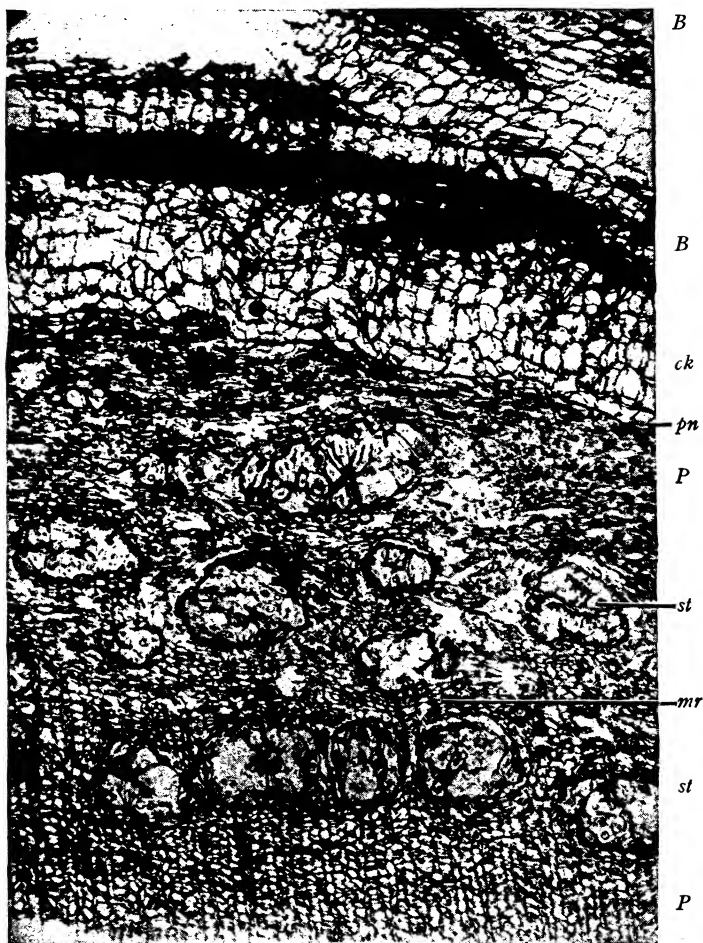


FIG. 450.—*Viburnum rufidulum* (Southern Black Haw). Stem Bark. Photomicrograph,  $\times 40$  diam. B, borke; ck, cork; pn, secondary phellogen; P-P, phloem; st, groups of stone cells; mr, phloem ray.

**Use.**—Uterine sedative in threatened abortion.

**Average Dose.**—4 Gm. (60 grains).

**Preparations.**—Viburnum Prunifolium Elixir (from Fldext.), 4 cc.; Viburnum Prunifolium Fluidextract, 4 cc.

**Substitutes and Adulterants.**—The barks of other species of *Viburnum* notably *V. nudum* L. commonly known as Shonny Haw or Shawnee Haw, *V. cassinoides* L. or Withe-rod, *Viburnum Lentago* L. or Sheepberry. The fluid



extracts of all of these have a valeric acid odor and a similar mild sedative action on the isolated uterus of rabbits, cats and dogs. The bark of *Viburnum dentatum* L. or Arrow-wood which is devoid of any known medicinal value. Excessive wood. The stem barks of *Viburnum cassinoides* and *V. nudum* possess a purplish-brown outer surface, and their old bark near the base of the trunk shows relatively small cork plates. *Acer spicatum* bark. Hobble-bush bark has occurred as an adulterant of the stem bark.

#### VIBURNUM OPULUS N.F. (VIBURNUM OPULUS)

**Synonyms.**—High Bush Cranberry Bark, True Cramp Bark, Wild Guelder Rose, Cranberry Tree Bush, *Ger.* Wasserholderrinde; *Fr.* Écorce d'Obier.

**Botanical Origin.**—*Viburnum Opulus* L. var. *americanum* (Miller) Aiton (*V. trilobum* Marshall).

**Part Used.**—The dried bark.

**Purity Rubric.**—Not more than 5 per cent. of adhering wood, not more than 2 per cent. of other foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—Southern Canada and Northern United States, growing wild in thickets along streams.

**Plant.**—A shrub attaining the height of 4 m. Leaves opposite, simple, petiolate, broadly ovate, palmately-veined and prominently 3-lobed, the lobes coarsely and irregularly toothed or nearly entire along the margin and acuminate at the apex, the middle lobe being frequently elongated; petiole grooved on upper surface with several stalked or sessile glands toward its apex and with a pair of elongated, slender, glandular stipules at its base. Inflorescence a broad, stalked compound cyme bearing greenish-white to white, conspicuous, neutral marginal flowers and numerous minute, inconspicuous, greenish fertile florets in peduncled cymes. Fruit a subglobular, scarlet drupe with a sour, succulent sarcocarp and a flat, stony endocarp enclosing a single seed.

**Production and Commerce.**—The commercial supplies of this bark are largely collected from plants growing wild in Michigan and other northern states. A small amount of this drug is also obtained from plants grown in the Pacific northwest.

**Description.**—Bark in strips, quills or chip-like fragments from 1 to 10 cm. in length and 0.5 to 3 mm. thick; outer surface of thinner pieces brownish gray to weak greenish yellow, the thicker pieces to dusky brown, sometimes with crooked longitudinal wrinkles and small light-colored lenticels; the thicker pieces from light gray and grayish brown to grayish-black or black (where abraded, greenish to brown) and thin scaly or finely fissured; inner surface greenish yellow to yellowish to rusty-brown, irregularly transversely to obliquely or longitudinally striated, except where wood adheres; fracture short with few or no projecting fibers in thinner bark to short and weak in thicker bark; the fractured surface showing a brown to rusty brown outer bark, a greenish phello-

derm and a pale brown to yellowish inner bark; odor valerian-like becoming more pronounced when the bark is triturated with a mineral acid; taste astringent and bitter.

**Microscopical Characteristics.**—Passing from outer to inner surface, the following peculiarities are evident:

**Young Bark.**—1. *Epidermis* with scattered stomata, frequently exfoliating or replaced by *cork*.

2. *Phellogen* present or absent (in very young twig bark).

3. *Primary cortex* of chlorenchyma or parenchyma consisting of an outer hypodermis or exocortex of more or less collenchymatous cells tending to be larger than most of the subjacent layers of the cortex which consist of parenchyma. Some of the cells of this region contain a greenish-yellow amorphous substance, others rosette aggregates of calcium oxalate or starch grains. Rifts occur in the inner part of the medicocortex.

4. *Pericycle* of parenchyma cells containing either rosette aggregates of calcium oxalate, small starch grains or amorphous substance. Here in very young bark occur the beginning of pericyclic fibers as isolated modified cells with empty lumen and clear thickened walls. As the bark becomes older the pericyclic fibers increase in number and in the lignification of their walls. Rifts appear in this region.

5. *Phloem* with strands of sieve tubes associated with phloem parenchyma (having starch, crystals or amorphous contents) and occasional or no bast fibers, and traversed by medullary rays 1 to 2 cells wide.

**Intermediate Bark.**—1. *Cork* of 5 to 25 layers of suberous cells having almost colorless walls. These layers ultimately become differentiated into alternating zones of suberized-walled and lignified-walled cells.

2. *Cork cambium*.

3. *Cortex* of a varying number of layers of cortical parenchyma cells containing either starch grains, rosette crystals of  $\text{Ca}\bar{\text{O}}$ , a brownish-yellow amorphous substance or chloroplasts.

4. *Pericycle*. Sclerenchyma fibers with lamellated walls and arranged either singly or in small groups of 2 to 10 in this region.

5. *Phloem*, a broad region composed of phloem patches separated by starch-containing medullary rays, 1–2 cells wide. Most of the elements of the phloem patches are sieve tubes and phloem cells. Stone cells and bast fibers may occur sparingly in this region but are not seen in every section. The stone cells appear to begin to occur in bark of the sixth year of growth. The phloem cells may contain either starch, rosettes of  $\text{Ca}\bar{\text{O}}$  or a reddish-brown amorphous substance. The starch grains are either simple or compound, the individual grains being usually 2–6 $\mu$  in diameter.

As the bark becomes older, secondary phellogens arise in cortex, pericycle and outer phloem causing a sloughing off of the primary bark tissues. These exfoliating tissues often adhere for long periods to the inner tissues forming borke in which sclerenchyma elements may be found imbedded in necrosed

parenchyma. This accounts for the presence of pericyclic fibers and a moderate number of bast fibers in the young bark of commerce and their almost complete absence in commercial older barks.

**Old Bark.**—Sections cut through bark of a stem 10 years old showed the bark portion  $1500\mu$  in thickness.

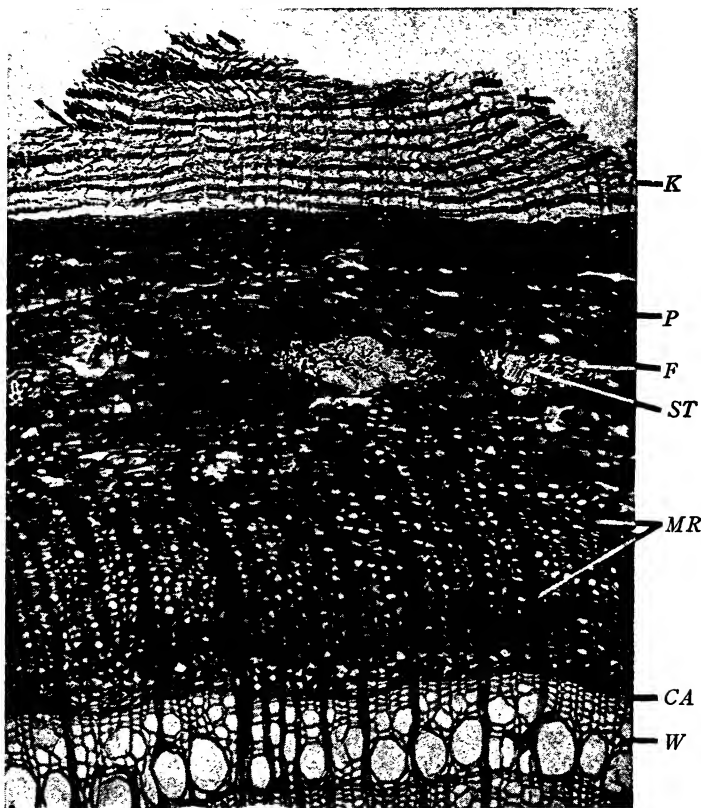


FIG. 451.—Transverse section of older stem bark of *Viburnum trilobum* (*Viburnum Opulus* var. *americanum*) with a small amount of adherent wood.  $\times 38$ . K, cork, showing alternate layers of lignified and non-lignified walled cells; P, phloem, F, fibers; ST, stone cells; MR, medullary rays; CA, cambium; W, wood.

These sections showed a complete absence of cortex and pericycle. The following bark structures were noted passing from periphery to center:

1. *Outer phloem region* of dead cells or completely exfoliated in some sections.
2. Several layers of *tabular cork cells* whose tangential walls are for the greater part both suberized and lignified. While the radial walls of most of the cells observed were suberized, a few showed lignification. Many of the cork cells showed ridge-like thickenings in their walls. The cork cells varied from  $17.7\mu$  to  $95.5\mu$  in length and from  $10.62\mu$  to  $35.4\mu$  in breadth.
3. A *secondary phellogen* of clear-looking meristematic cells in the process of division.

4. A broad *secondary phloem* separated into a number of irregularly oblong phloem patches by numerous medullary rays which run nearly straight in the inner region but which for the greater part pursue curved courses in the outer portion of the phloem. Most of the phloem patches consist of starch- and crystal-containing phloem parenchyma and sieve tubes, but scattered here and there intercepting medullary rays were observed, some groups of sclerenchyma consisting of stone cells of variable size and shape some of which are elongated and fiber-like.

The sclerenchyma groups are for the greater part widely scattered but occasionally are found fairly close, never, however, as numerous as in the older *Acer spicatum* stem bark. A few isolated stone cells are also present. In some sections the groups assumed a tier-like arrangement but, unlike the sclerenchyma fibers of *Acer spicatum* bark, had broad intervening spaces of soft bast between the series of groups.

A striking feature of these sections was the great abundance of rosette aggregates of calcium oxalate.

Radial-longitudinal sections showed many cells in the outer phloem with brownish to reddish contents and thick lamellated walls. These in some places were disposed in groups, the groups appearing collenchymatous.

The cork cells are tangentially-elongated and for the greater part are lignified on their tangential walls. Here and there a pericyclic fiber is imbedded in the cork mass. Calcium oxalate crystals in the form of rosette aggregates are very numerous, the larger crystals measuring up to  $42.48\mu$  in diameter. Most are up to  $35.4\mu$ . Stone cells of a large variety of shapes and thickenings occur, some with hooked and crenated margins. Some of the stone cells are elongated and appear like fibers but usually show distinct pore canals. The stone cell groups measure up to  $1499\mu$  in length and up to  $416.5\mu$  in width.

The medullary rays traverse the other elements at right angles, their cells showing thick porous walls and starch, tannin or rosette crystals, occasionally reddish brown contents.

Tangential-longitudinal sections exhibit numerous medullary rays 1 cell in width and a scattering of others 1–2 cells in width, more rarely in some sections a medullary ray is seen 1–3 cells wide. In this type of section the medullary ray cells appear rounded ovate to ellipsoidal. Some isolated stone cells of variable outline are also seen. The cork cells appear tangentially-elongated and many show lignification on their tangential walls. Numerous crystal fibers containing rosette aggregates of calcium oxalate are present as well as isolated rosette aggregates, the latter occurring in many of the parenchyma and medullary ray cells.

**Powdered Drug.**—Pale brown to weak yellowish orange. Numerous fragments of starch and crystal bearing parenchyma and medullary-ray cells, the latter with beaded walls; starch grains mostly small, somewhat less numerous than in the root bark and frequently adherent to walls and dead protoplasm of parenchyma cells, the grains spheroidal to ovoid, very small and usually not

exceeding  $6\mu$  in diameter; a few thick-walled pericyclic fibers; numerous fragments of brownish cork tissue with cells of polygonal or tabular outline, the latter usually in layers and showing thickened tangential and occasionally radial

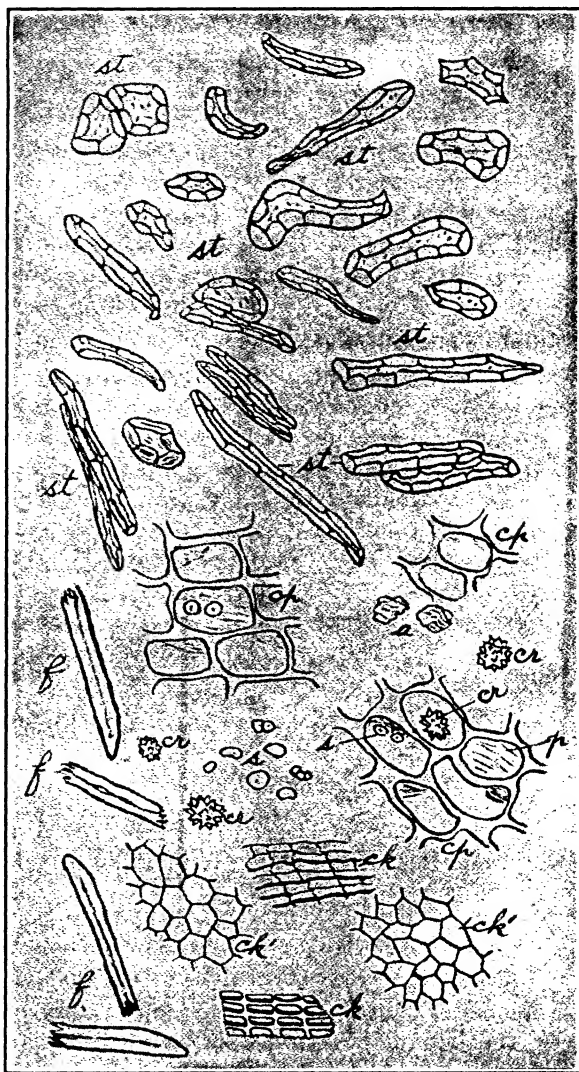


FIG. 452.—Powdered *Viburnum Opulus* stem bark. *st*, stone cells; *cp*, cortical parenchyma; *a*, resinous material occurring in parenchyma of bark; *s*, starch grains; *cr*, rosette aggregates of calcium oxalate; *f*, sclerenchyma fibers; *ck*, cork tissue in transverse section; *ck'*, cork in surface view. (From Youngken, *Jour. A.Ph.A.*, 21 (1932) 459.)

walls, walls of cork cells suberized to lignified; the polygonal cork cells usually up to  $70.8\mu \times 35.4\mu$ , the tabular up to  $106.20\mu$  in length and up to  $35.4\mu$  in width; stone cells of a variety of shapes and degrees of lignification up to  $124\mu$  long and  $35.4\mu$  in breadth; numerous rosette aggregates of calcium oxalate up

to  $42.48\mu$  in diameter; a few fragments of adherent wood elements (practically unavoidable in preparation) consisting of lignified wood fibers with oblique and bordered pits and scalariform and pitted tracheæ.

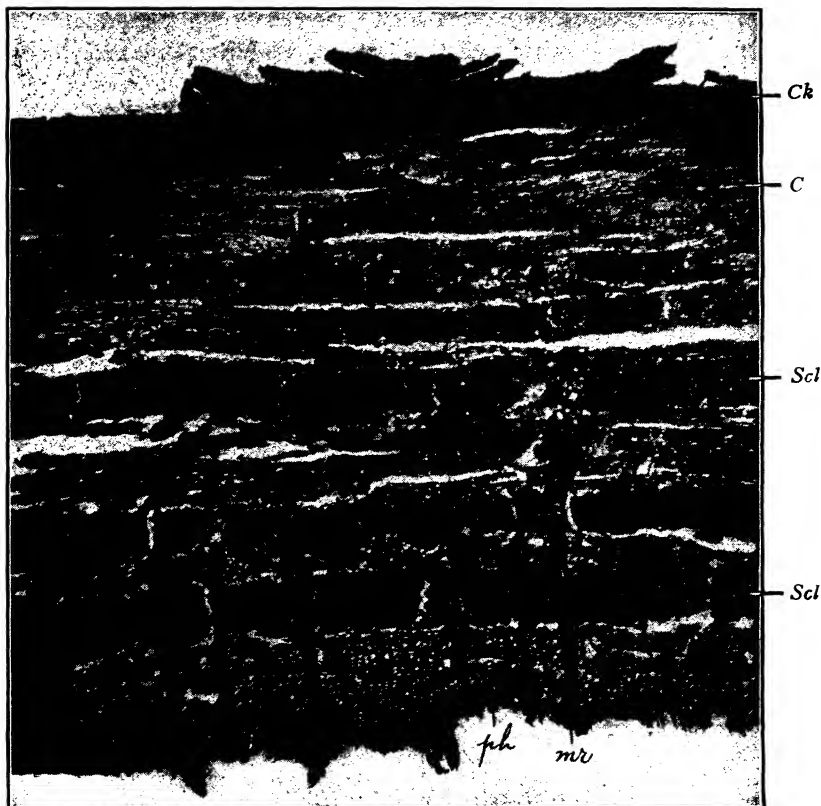


FIG. 453.—Transverse section of mountain maple bark (*Acer spicatum*). Cork (*Ck*); cortex (*C*); sclerenchyma fibers in groups (*Scl*); medullary-ray (*mr*); phloem patch (*ph*) between two medullary rays.

**Constituents** —*Viburnin* (glycoside), an enzyme which splits viburnin into valeric acid and glucose; resin, tannic acid, 0.1 to 0.3 per cent. of *volatile oil* containing about 50 per cent. of free acids, including capric, caprylic, caproic, valeric, butyric, propionic and acetic; phenols, aldehydes and esters;  $\alpha$  and  $\beta$ -amyrins, etc.

**Uses.**—Antispasmodic and uterine sedative.

**Average Dose.**—4 Gm. (60 grains).

**Preparations** (unof.).—Fluidextractum Viburni Opuli, 4 cc.; Elixir Viburni Opuli Compositum, 4 cc.; Tinctura Viburni Opuli Composita, 4 cc.

**Adulterants and Substitutes.**—(1) Mountain Maple Bark, the bark of *Acer spicatum* Lam. (Fam. *Aceraceæ*). This differs from *Viburnum Opulus* chiefly in attaining a greater thickness, in being decidedly more astringent, by possess-

ing a pronounced fibrous fracture, in being devoid of a valeric acid odor, and in showing internally tiers of lignified sclerenchyma fibers in cortex, pericycle and phloem as well as scattered monoclinic prisms of calcium oxalate.

(2) Hobble-bush Bark, the stem bark of *Viburnum alnifolium* Marsh, has been collected in the southern Blue Ridge district and marketed as "Cramp Bark" and "Southern Cramp Bark." It has also been occasionally found admixed with commercial lots of *Viburnum Prunifolium* stem bark. It varies somewhat in its physical characteristics depending upon whether it has been collected from younger or older portions of the stems. That from younger growth, as occurring on twigs, is externally purplish to purplish brown, smooth and polished with scattered circular to oval, raised lenticels and less than 0.5 mm. in thickness when dried. The fracture of its outer and middle bark is short, that of the inner bark, short-fibrous, the fractured surface showing projections of fibers in the inner bark and this region frequently separating in the process of breaking and exposing the greenish middle bark. The inner surface of this young twig bark is pale brown and longitudinally striate on pieces of entire bark, but many pieces of commercial young bark are devoid of inner bark and so exhibit the green color of the middle bark.

The dried bark from older portions of the stem varies on its outer surface from purplish brown, through dark brown to blackish brown. Some pieces show grayish foliaceous lichens, some light brown lenticels, while others exhibit irregular longitudinal fissures, cracks and ridges. As this bark becomes older, the cork becomes cracked in irregular longitudinal fashion and through these cracks the greenish to light-colored subjacent tissue is to be noted. It also becomes scaly, the scales representing dead cork tissue in the process of exfoliation.

The fracture of the older bark is short in the outer bark zone and fibrous in the inner bark. The cork is readily detachable in areas on some of the pieces, while other pieces exhibit partly detached outer, middle and inner zones of bark. The inner surface of older pieces of bark varies from pinkish brown to pale brown and is finely longitudinally striate to nearly smooth; that of many pieces of commercial bark exhibit a whitish, adherent wood. Many of the commercial samples of this substitute show admixture of twigs of purple to purplish-brown color which possess a large, white pith and also show occasional naked winter buds of the same shrub. The latter are up to about 2.3 cm. long, cinnamon-brown to purplish-brown in color and covered with a rufous tomentum. Toward the base of the older stems of *Viburnum alnifolium* the outer bark is grayish-black and scaly with the cork separated by short fissures into numerous small polygonal plates. The odor of this bark is slight when dry, but characteristically valerian-like when boiled with water or triturated with phosphoric acid. Transverse sections of Old Stem Bark, of *V. alnifolium* 2.88 mm. to 3 mm. in radial diameter exhibit the following structures:

1. *Periderm* of many alternating layers of thin-walled and thick-walled cork tissue and a phellogen. The thick-walled cork cells are orange to brown in color and more or less collapsed. Their walls become lignified in older bark.

2. *Secondary cortex* of up to 10 layers of collenchyma, the cells containing either starch grains, druses or resinous substance. The druses are up to  $40\mu$  in diameter.

DISTINCTIONS BETWEEN VIBURNUM BARKS AND ADULTERANTS

<i>V. Prunifolium</i> Root Bark	<i>V. Prunifolium</i> Stem Bark	<i>V. Alnifolium</i> Stem Bark	<i>V. Opulus</i> Stem Bark	<i>Acer Spicatum</i> Stem Bark
<b>Cork</b> Lignified with orange to brown content	Cork suberized to lignified with orange to brown contents	Alternating layers of thin-walled and thick-walled cells, discontinuous	In continuous alternating layers of suberized and lignified walled cells	Cork cells lignified with brown contents
<b>Cortex</b> Secondary with stone cells in groups or isolated	Primary and secondary with stone cells	Starch and crystal-bearing parenchyma cells. Stone cells occasional	Starch and crystal-bearing parenchyma	Numerous sclerenchyma fibers and stone cells
<b>Pericycle</b> Absent	Relatively few fibers	Numerous groups of pericyclic fibers	Groups of pericyclic fibers in young and intermediate bark	Numerous groups of sclerenchyma fibers and isolated stone cells
<b>Phloem</b> Numerous stone cells in groups with red to brown contents. Bast fibers absent	Numerous stone cells in groups. Bast fibers absent	Bast fibers numerous in groups arranged in tiers	Stone cells and bast fibers occasional in intermediate and old bark	Dense groups of bast fibers arranged in tiers; scattered occasional stone cells
<b>Calcium Oxalate</b> Rosette aggregates, monoclinic prisms, and crystal fibers containing these crystals	Rosette aggregates and monoclinic prisms, crystal fibers, containing rosette aggregates and monoclinic prisms	In rosette aggregates and crystal fibers containing rosette aggregates	Rosette aggregates and crystal fibers containing rosette aggregates	In monoclinic prisms only
<b>Starch</b> Simple and 2- to 3-compound, up to 23 microns in diameter	Simple and 2- to 3-compound, up to 23 microns	Simple and 2- to 3-compound, mostly up to 8 microns, occasionally up to 15 microns	Simple, spheroidal, and up to 6 microns	Simple and 2- to 4-compound, mostly under 6 microns

3. *Primary cortex* of several layers of starch- and crystal-containing parenchyma, the cells tangentially elongated. Several rifts occur in the cortical zones.

4. A *pericycle* consisting of a narrow zone of starch- and crystal-bearing parenchyma in which occur numerous groups of pericyclic fibers with lignified walls.



5. *Phloem*, consisting of a relatively very broad zone separated into many oblong phloem patches by phloem rays, the latter 1 to 2 cells in width. A large number of bast fibers with lignified walls and occurring either isolated or in groups of from 2 to 12 occur in every phloem patch.

*Powdered Viburnum Alnifolium Stem Bark*.—Light brown. Starch grains mostly simple, a few from 2- to 3-compound, the individual grains mostly under  $8\mu$  in diameter and of spheroidal, oval or plano-convex shape with central cleft hilum; numerous fragments of starch- and crystal-bearing parenchyma and collenchyma, an occasional starch grain up to  $15\mu$ ; with slightly excentric, cleft hilum; numerous rosette aggregates of calcium oxalate up to  $40\mu$  in diameter; fragments of cork tissue of brown or orange color and of irregularly polygonal or rectangular cells with brown, amorphous contents, the cork often adherent to subjacent collenchyma; numerous fragments containing sclerenchyma fibers having narrow, irregular lumina and with thick, non-lignified to lignified, frequently irregular, wavy walls, the latter from about 4 to  $12\mu$  in thickness; an occasional stone cell or group of stone cells, the latter with broad lumina.

This bark has been found to be toxic to dogs in addition to possessing a depressor-uterine sedative action. For further details see *Jour. A. Ph. A. Sci. Ed.* 29 (1940), 439.

#### VALERIANACEÆ (VALERIAN FAMILY)

Herbaceous often low succulent plants with creeping rhizomes, frequently strongly scented and possessing stimulating properties. Leaves frequently dimorphic; the radical fascicled; the cauline opposite; petiole dilated, exstipulate. Inflorescence a raceme of dichesial or scorpioid cymes. Flowers more or less irregular; calyx absent as such but represented by a series of teeth that are incurved in the bud and flower and which expand later into a pappose crown and act in the fruit as a pappose disseminator; corolla pentamerous, gamopetalous, varying from rotate-synpetalous to irregular-tubular with petals diversely united, in color varying from greenish-white to white or pink (*Valeriana officinalis*) to crimson; stamens three, rarely two or one, epipetalous; pistil syncarpous; ovary inferior, 3-celled, only 1 cell being fertile; style filiform with three stigmatic surfaces. Fruit an akene from inferior ovary crowned by a persistent, expanded, pappose, calyx rudiment. Seeds anatropous, exalbuminous.

The most important histological features comprise the following: Absence of calcium oxalate; presence of secretion sacs, frequently in subepidermal layer of roots, containing volatile oil and possessing suberized walls; tracheæ with scalariform markings or simple pores.

#### VALERIAN N.F. (VALERIANA)

**Synonyms.**—Wild, Great Wild, Setwall, St. George's Herb, Cat's Valerian, Vandal Root, Garden Heliotrope; *Ger.* Baldrianwurzel; *Fr.* Racine de Valeriane.

**Botanical Origin.**—*Valeriana officinalis* Linné.

**Part Used.**—The dried rhizome and roots.

**Purity Rubric.**—Not more than 4 per cent. of foreign organic matter and not more than 8 per cent. of acid-insoluble ash.

**Habitat.**—Europe and Asia.

**Plant.**—A tall perennial herb whose underground portion consists of a vertical rhizome bearing numerous rootlets and one or more stolons. The aerial portion consists of a cylindrical, hollow, channelled stem, branched in the terminal region, bearing opposite, exstipulate, pinnatisect, cauline leaves with clasping petioles. The inflorescences consist of racemes of cymes whose flowers are small, white or pink. The fruits are oblong-ovate, 4-ridged, 1-seeded akenes.

**Production and Commerce.**—*Valeriana officinalis* is cultivated as a drug plant in various localities of the United States but mainly in England, Belgium, Holland, Russia and Germany. It thrives best in rich, heavy, loamy soil which is abundantly supplied with moisture. The plants may be propagated from seeds or by dividing old roots. If grown from seeds, the seeds should be planted in cold frames or in protected beds in the autumn and the seedlings transplanted to the field in April or as soon as frost has disappeared. They should be set at least a foot apart and in rows wide enough apart for cultivation. Divided old roots should be planted in the field in the early autumn and set the same distances apart as the seedlings. The rhizomes and roots should be dug up in the autumn of the second year, the thicker rhizomes cut into longitudinal slices, washed and carefully dried by artificial heat. English Valerian has been considered the best in the past. Most of the drug has been imported from Belgium, Canada, Mexico and Japan.

**Description.**—Rhizome vertical, from 2 to 4 cm. in length and from 1 to 2.5 cm. in diameter, entire or usually cut into 2 to 4 longitudinal pieces; externally weak brown to moderate yellowish-brown or dark brown, upper portion with stem bases and leaf scars and frequently with a short horizontal stolon, the outer surface showing numerous slender, brittle rootlets and occasional root scars; fracture of rhizome short and horny; internally brown to moderate yellowish-brown, with a thick bark and narrow central cylinder; odor characteristically valeric acid like, becoming stronger on ageing; taste sweetish, camphoraceous and somewhat bitter.

**Histology.**—Transverse sections of the rhizome show the following structures:

1. *Cork*, a narrow zone of suberous tissue.
2. *Cork cambium* of meristematic cells.
3. *Cortex*, of cortical parenchyma cells, most containing starch grains, some resin. Through this region course scattered root- and leaf-trace bundles. Stone cells in scattered groups have been observed in some sections.
4. *Endodermis*, a layer of altered cells, possessing globules of volatile oil.
5. *Fibrovascular bundles* of the collateral type, somewhat twisted.
6. *Medulla*, a broad zone of starch-containing parenchyma, containing islets of stone cells.

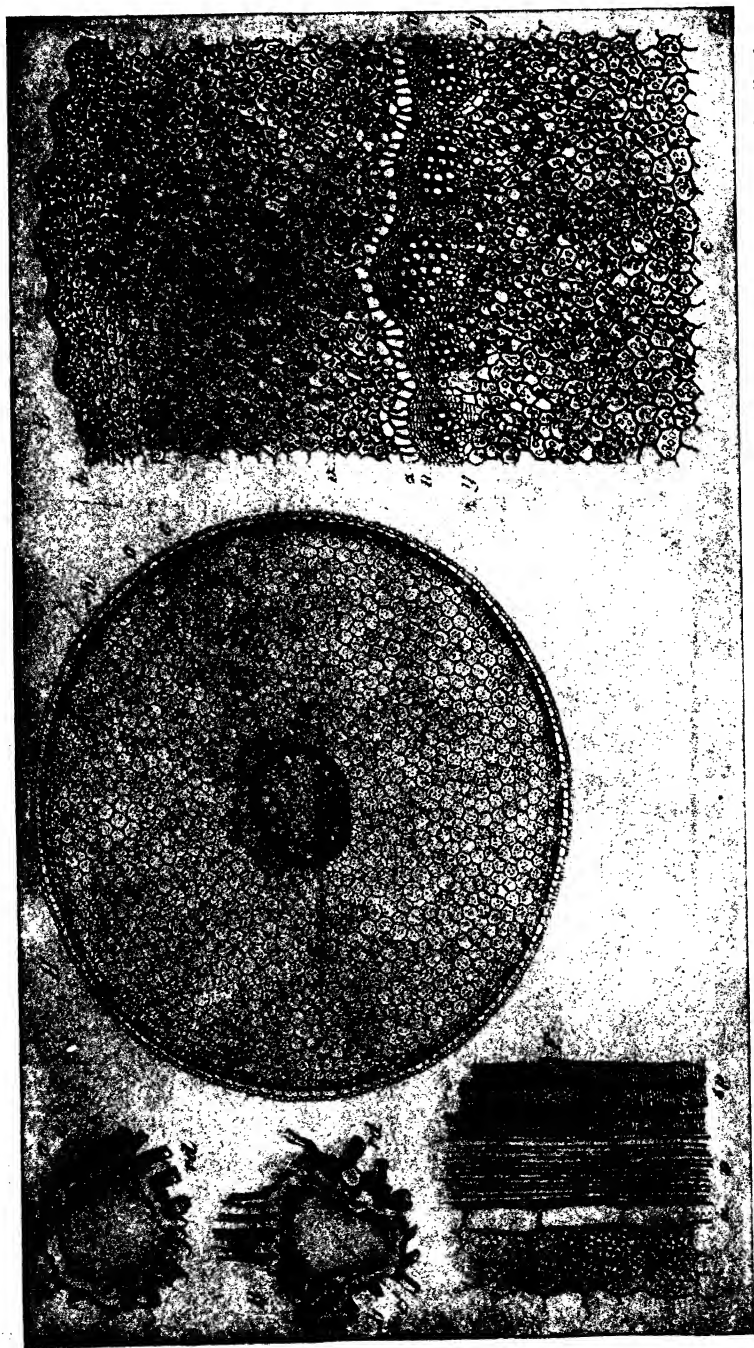


FIG. 454.—*Valeriana officinalis*. A, Transverse section of rhizome with lateral rootlet stumps (nat. size). B, Longitudinal section of rhizome showing leaf remnants above and lateral rootlet stumps (nat. size). C, Transverse section of stolon showing a few starch-parenchyma cells, endodermis, cambium, and pitted tracheae of xylem. D, Radial-longitudinal section of a representative portion of stolon showing a few starch-parenchyma cells, endodermis, cambium, and pitted tracheae of xylem. E, Transverse section of root, X 65. F, Transverse section of root, X 65. G, Transverse section of root, X 65. H, Transverse section of root, X 65. I, Transverse section of root, X 65. J, Transverse section of root, X 65. K, Transverse section of root, X 65. L, Transverse section of root, X 65. M, Transverse section of root, X 65. N, Transverse section of root, X 65. O, Transverse section of root, X 65. P, Transverse section of root, X 65. Q, Transverse section of root, X 65. R, Transverse section of root, X 65. S, Transverse section of root, X 65. T, Transverse section of root, X 65. U, Transverse section of root, X 65. V, Transverse section of root, X 65. W, Transverse section of root, X 65. X, Transverse section of root, X 65. Y, Transverse section of root, X 65. Z, Transverse section of root, X 65. (After Berg.)

Transverse section of the rootlets show the following peculiarities:

1. *Epidermis*, consisting of a single layer of papillose cells, a number showing outgrowths as root hairs. Cork replaces epidermis in older rootlets.
2. *Hypodermis*, a layer of subepidermal cells, some of which are modified as secretion sacs. These have suberized walls and usually contain small volatile oil globules, occasionally small prismatic crystals.
3. *Cortical parenchyma* of several layers of cells, most of which are filled with simple and compound starch grains; a few near the hypodermis may contain oil globules.
4. *Endodermis*, a single layer of thin-walled endodermal cells with thickened radial walls.
5. *Pericambium*, a layer or two of thin-walled cells.
6. A radial *fibrovascular bundle*.
7. *Pith*.

**Powdered Drug.**—Weak brown to moderate yellowish brown; numerous starch grains, from 3 to  $23\mu$  in diameter, spherical, plano-convex, polygonal, or 2- to 4-compound, each generally exhibiting a central cleft; fragments of pitted, scalariform and reticulate tracheæ as well as tracheæ with bordered pores; fragments of sclerenchyma fibers with thin lignified walls; fragments of cork and epidermis, the latter often showing root hairs; fragments of parenchyma, some cells of which are modified as secretion sacs and contain globules of oil.

**Constituents.**—*Volatile oil* (up to 2 per cent.) containing *bornyl isovalerianate*, *bornyl formate*, *bornyl acetate* and *bornyl butyrate*, camphene, *borneol* and pinene; 2 alkaloids, *chatinine* and *valerianine*, a glucoside, resin,  $\alpha$ -methylpyrrol ketone, stated to be narcotic, *valeric*, formic and acetic acids, tannin, sugar, etc.

**Use.**—Valerian is used as a calmate in nervousness and hysteria and as a carminative.

**Average Dose.**—0.75 Gm. (12 grains).

**Preparations.**—Valerian Fluidextract, N.F., 1 cc. (15 minims); Valerian Tincture, N.F., 4 cc. (1 fl. dr.); Ammoniated Valerian Tincture, N.F., 2 cc. (30 minims).

**Adulterants and Substitutes.**—Rhizomes and roots of (1) *Valeriana toluccana* and (2) *V. mexicana* DC. from Mexico. Both of these contain a volatile oil and valeric acid. (3) Rhizomes and roots of *Valeriana Phu* L. from the Caucasus region. The rhizome is about twice as long as that of the official article and shows rootlets only on one side. This drug contains only about half as much volatile oil and valeric acid as true Valerian. (4) Rhizomes and roots of *Valeriana officinalis* var. *latifolia* Miq. and *V. officinalis* var. *angustifolia* Miq. (*Valeriana angustifolia* Tausch) or Japanese Valerian which yields up to 8 per cent. of a viscid, pale green, volatile oil containing *l*-bornyl isovalerianate and acetate, kessyl acetate and terpenes. This substitute occurs as flattened masses of rhizomes and roots or separated portions up to about 10 cm. in length. It differs chiefly from European Valerian in its darker color, its denser and thicker roots, in the bluish to black color of its fractured surface and in its peculiar, stronger, unpleasant, camphoraceous odor. Its histology resembles that of the

European species, differing from it chiefly by the presence of a larger number of altered starch grains and the more abundant resin cells in the cortex of the rhizome. (5) Rhizomes and roots of *Veratrum* species; (6) Rhizomes and roots of *Cypripedium macranthum*. (7) Indian Valerian from *Valeriana Wallichii* DC., native to the Himalaya and Khasia Mts., was recognized by the First Supplement to the N. F. VII and by the British Pharmacopoeia Addendum IV as a permissible substitute for European Valerian until further notice. This drug approaches more nearly the European Valerian in its chemistry than the other Valerian species thus far examined. It consists of more or less curved, dull brown rhizomes from 3 to 8 cm. in length and from 5 to 10 mm. in diameter, externally showing numerous root scars, a few rootlets or rootlet stubs and raised annulations representing leaf scars, and a crown of shrivelled remnants of leaf stalks. It yields up to about 1 per cent. of volatile oil containing esters of isovalerianic and formic acid.

#### CUCURBITACEÆ (GOURD FAMILY)

Herbaceous, very often annual (*Colocynth*, etc.), more rarely perennial (*Bryonia*, etc.), sometimes shrubby plants, the perennial and shrubby forms perennating by swollen roots, some of which are heavy and tuberous. Stems very usually grooved and ridged, often provided with roughened and barbed hairs. Tendrils are frequently produced in the axils of leaves from tendril axillary buds (Pumpkin, *Colocynth*, Watermelon, Cucumber, Bryony, etc.). Leaves varying from entire, simple, usually deltoid to triangular through stages of trilobate, pentalobate, deeply palmatifid to palmatipartite to seldom approaching compound (*Colocynth*). Venation in nearly all cases palmate. Leaves thin, herbaceous, much expanded, often hairy. Vascular bundles of petioles, branches and stems, bicollateral. Inflorescence either of loose cymes or more frequently racemes or spikes or entire axillary inflorescence may become solitary-axillary. Flowers pentamerous, very rarely tetramerous, monœcious (*Bryonia alba*) or diœcious (*Bryonia dioica*); sepals five, gamosepalous, adnate to ovary; corolla of five, rarely four gamopetalous petals, varying in size and shape from small to large campanulate or broadly cup-shaped (Cucumber) and in color from greenish-yellow to greenish-white to pure yellow to yellowish-white to white; stamens typically five, epigynous, with anthers either joined by pairs or synantherous; carpels usually three; ovary inferior, one- to three-celled. Fruit a pepo (a berry from an inferior ovary with thick skin) or berry. Seeds flat and exalbuminous.

#### PEPO (PEPO)

**Synonyms.**—Pumpkin Seed, Pompion; *Ger.* Kürbissamen; *Fr.* Semences de Potirons.

**Botanical Origin.**—Cultivated varieties of *Cucurbita Pepo* Linné.

**Part Used.**—The dried ripe seed.

**Habitat.**—Tropical America.

**Plants.**—Annual, running, monoecious herbs with dark green, non-glossy, 3-5 lobed leaves and prickly stems and petioles. The flowers are large and yellow being arranged singly in the axils of leaves. With the gradual widening of the corolla toward the top, its lobes become upright and pointed. Calyx lobes are narrow. The gourd-fruit differs in size and shape in the many cultivated varieties, and the toughened, furrowed peduncle does not enlarge near it.

**Production and Commerce.**—The seeds are gathered from the fruits of varieties of *Cucurbita Pepo* grown in this country as field and pie pumpkins. They are dried in the sun or by artificial heat.

**Description.**—Broadly elliptical or ovate, flattened, from 15 to 23 mm. in length and 2 to 2.5 mm. in thickness; externally yellowish-white, smooth with a flat ridge and shallow groove parallel to and within 1 mm. of the margin; fracture short; spermoderm consisting of a white coriaceous outer layer and a green membranous inner layer; embryo white, oily, consisting of 2 plano-convex cotyledons and a short conical hypocotyl; odor indistinct; taste bland and oily.

**Constituents.**—Up to 30 per cent. of a fixed oil consisting of a glyceride of linoleic acid, olein, palmitin and stearin; *resin*, protein, starch, etc. The active constituents are stated to be resinous in character and located in the embryo and green membrane.

**Use.**—*Taeniafuge* in the form of coarsely ground or bruised seeds.

**Average Dose.**—30 Gm. (1 ounce), given on an empty stomach and followed by a cathartic.

#### COLOCYNTH N.F. (COLOCYNTHIS)

**Synonyms.**—*Colocynth Pulp*, Colocynth Apple, *Bitter Apple*; *Fr.* Coloquinte; *Ger.* Coloquinthenapfel.

**Botanical Origin.**—*Citrullus Colocynthis* (Linné) Schrader.

**Part Used.**—The dried pulp of the unripe but full-grown fruit.

**Purity Rubric.**—Not more than 5 per cent. of seed and not more than 2 per cent. of epicarp. It yields not more than 2 per cent. of anhydrous extractive with purified petroleum benzin and not more than 4 per cent. of acid-insoluble ash.

**Habitat.**—Asia and Africa.

**Plant.**—A monoecious, perennial vine with an angular hispid stem bearing long-petioled, palmately cleft to parted leaves and short tendrils. The flowers are yellow and axillary. The fruit is a greenish-yellow, globular, 3-celled berry, becoming spuriously 1-celled on ripening.

**Production and Commerce.**—The Colocynth plant grows wild in Mediterranean countries and has been cultivated in India, Turkey, Spain, Cyprus, the Soudan, England and New Mexico. The berries are collected when turning yellow in autumn, and, after the epicarps are removed by peeling, are dried in the sun or by fire. The seeds constitute about 75 per cent. of the weight of the fruits. Colocynth occurs on the American market as pulp (*Colocynth Pulp*) and as whole fruits with the epicarp removed (*Colocynth Apples*). Most of the drug now being imported into this country comes from the Soudan

through Egypt. It is concentrated around Omdurman and Khartoum on the White Nile and is then shipped through Cairo to the United States. The pulp

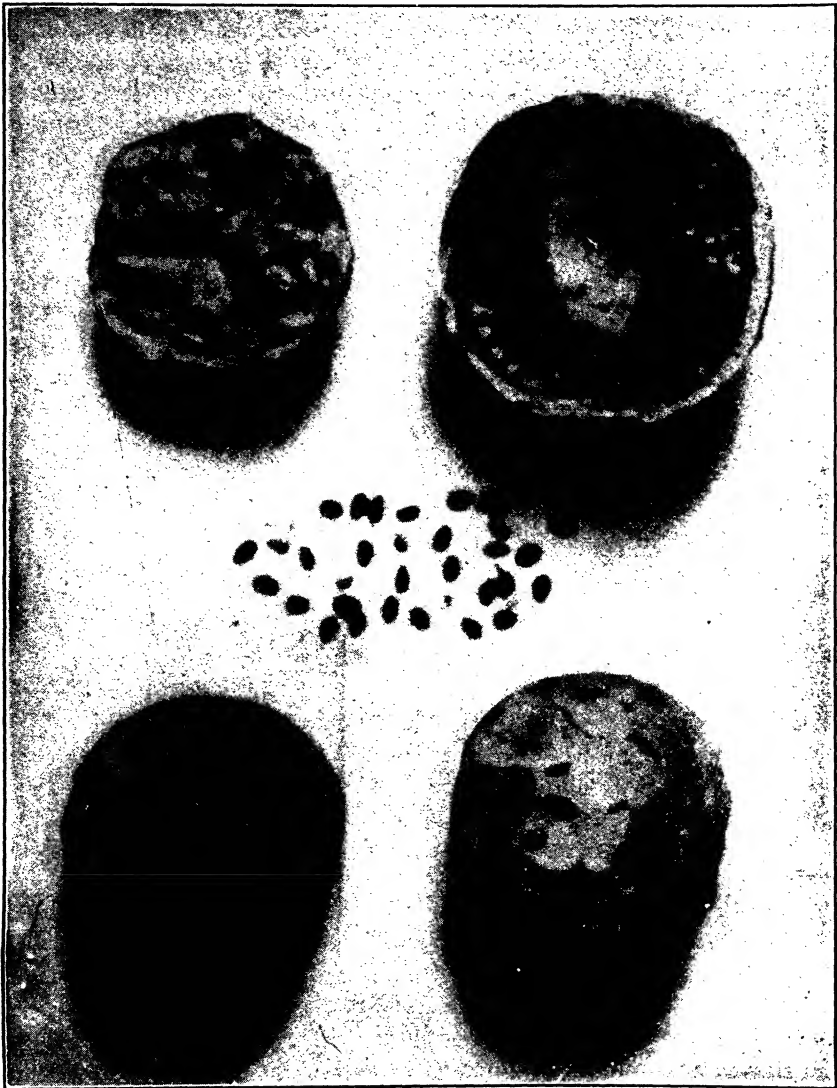


FIG. 455.—Colocynth apples. In lower part of figure are two fruits (berries) deprived of their epicarp. Upper figure to left shows the surface of a fruit cut crosswise. Note the three elliptical fissures with divided placentas between these bearing many seeds. Upper figure to right shows a longitudinally cut surface of fruit. Note groove, placenta and seeds. Seeds at center,  $\times \frac{3}{4}$ .

is usually packed in large bales, the "apples" in cases. From 5 to 30 per cent. of seeds have been found in importations of the pulp.

**Descriptions.**—*Whole “Colocynth Apple.”*—Berries, before the removal of the seeds, subspherical, from 4 to 10 cm. in diameter with few small patches of adherent epicarp; internally with 3 large lenticular cavities between the 3 carpels; pale yellow to yellowish-orange, and spongy; separable longitudinally, when entire, into 3 carpels, each containing near the outer surface compressed, ovoid, yellowish-orange to brown seeds; odor slight; taste intensely bitter.

*Colocynth Pulp.*—In light, spongy, readily broken pieces; light yellowish orange to pale yellow with occasional small patches of darker epicarp; odor slight; taste intensely bitter.

**Histology of Pulp.**—Sections of the official drug show mostly large, thin-walled pitted parenchyma traversed by bicollateral vascular bundles with spiral tracheæ, and occasional irregular, tubular laticiferous vessels.

**Powdered Drug.**—Weak yellowish-orange to yellowish-gray; numerous fragments of large celled, thin-walled, parenchyma; few fragments of epicarp with polygonal cells; occasional fragments of spiral tracheæ; very few or no nearly isodiametric stone cells of the seed coat whose walls are lignified, possess pores and are either straight or wavy; few oil globules and aleurone grains from seed impurity. The powdered drug should yield not more than 2 per cent. of fixed oil.

**Constituents.**—*Resins* and an *alkaloid* (both purgative), *a-elaterin*, a crystalline alcohol called citrullol, gum, etc.

**Use.**—Hydragogue cathartic.

**Average Dose.**—0.125 Gm. (2 grains).

**Preparations.**—In N.F.: Colocynth Extract, 30 mg. ( $\frac{1}{2}$  gr.); Compound Colocynth Extract (from Ext.), 0.25 Gm. (4 gr.); Compound Colocynth and Jalap Pills (from Comp. Ext.), 1 pill; Compound Mild Mercurous Chloride Pills (Compound Cathartic Pills), 2 pills.

#### BRYONIA N.F. (BRYONIA)

**Synonyms.**—*Bryony*; *Fr.* Couleuvrée; *Ger.* Zaunrübe.

**Botanical Origin.**—*Bryonia alba* Linné and *Bryonia dioica* Jacquin.

**Part Used.**—The dried root.

**Limit of Impurities.**—2 per cent. of foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—Europe.

**Plants.**—Perennial climbing vines, monoecious (*B. alba*) or dioecious (*B. dioica*) bearing cordate, palmately 5-lobed leaves and small greenish-white to yellowish axillary flowers. The fruits are black (*B. alba*) or red (*B. dioica*) berries.

**Production and Commerce.**—The spindle-shaped roots are dug up in late summer or early autumn, washed, cut into transverse slices and carefully dried. They are packed in sacks and shipped to Trieste and London whence they are exported to this country.

**Description.**—Usually in circular or elliptical slices from 1.5 to 10 cm. in breadth and up to 15 mm. in thickness; light gray, weak yellowish orange or



moderate yellow, rough and striate, the cut surface showing a thin cortex and broad wood, the latter exhibiting several concentric zones of collateral fibro-vascular bundles; fracture short and mealy; whitish internally, odor characteristic but faint, taste bitter and nauseous.

**Powdered Drug.**—Weak yellowish-orange to weak yellow; fragments of parenchyma, numerous starch grains, both simple and 2- to 6-compound, the individual grains spheroidal, plano-convex and polygonal usually with a central hilum, and from 4 to 25 $\mu$  in diameter, frequently with a central cleft; fragments

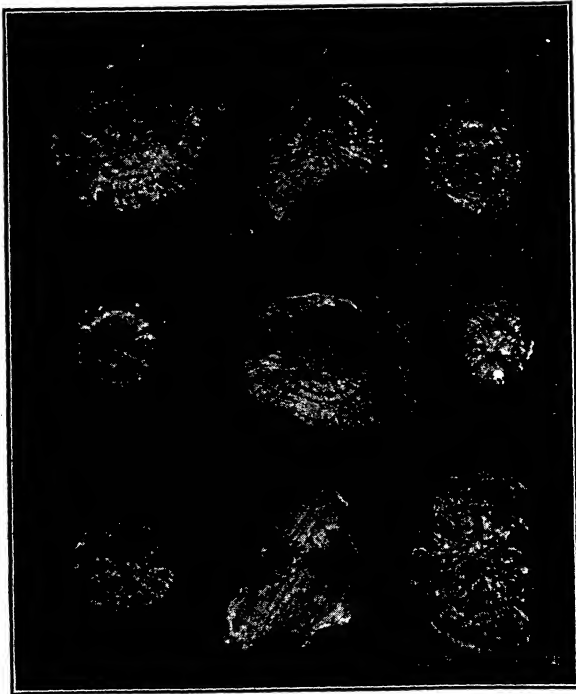


FIG. 456.—*Bryonia*,  $\times \frac{1}{4}$ .

of broad tracheæ up to 250 $\mu$  in width, reticulate or with bordered pore markings; large yellow cork fragments.

When sulphuric acid is added to the powder it becomes brown and then red-purple.

**Constituents.**—A dark brown *resin* called *bryoresin* (purgative), a glycoside called *bryonidin* which has a paralytic effect on the central nervous system, a mixture of alkaloid and glycoside called bryonin, which is physiologically inactive, an alcohol termed bryonol, phytosterol glycoside, etc.

**Uses.**—Bryony is used as a hydragogue cathartic and diuretic, in pleurisy, dropsy, bronchitis, tonsilitis, etc.

**Average Dose.**—1 Gm. (15 grains).

**Preparation.**—*Tinctura Bryoniæ*, 4 cc. (1 fl. dr.).

## ELATERINUM (ELATERIN)

**Synonyms.**—*Ger.* Elaterin; *Fr.* Elatine.

**Botanical Origin.**—*Ecballium Elaterium* (Linné) A. Richard.

**Part Used.**—A substance obtained from the juice of the fruit.

**Habitat.**—Mediterranean Region. Cultivated in England, Malta, and continental Europe.

**Plant.**—A perennial, rough-hairy, trailing vine known as the Squirting Cucumber on account of its explosive fruits. It bears entire to 3-lobed, heart-shaped leaves, yellow flowers and oblong prickly fruits which, when mature, separate from their stalks and dehisce at the slightest touch, squirting their seeds through the opening in the base.

**Production.**—The fruits are gathered green, sliced, and the juice pressed out. Upon standing for at least 2 hours the juice deposits a sediment which is separated by straining through calico or cheese cloth, dried and constitutes the article known as *Elaterium*. *Elaterium* occurs in pale green (when fresh) to gray or buff colored, opaque, irregular shaped, flat pieces, the surfaces of which show crystals of elaterin. From *Elaterium*, the elaterin can be obtained by evaporating an alcoholic tincture to the consistency of a thin syrup and transferring this while still hot to a weak boiling solution of caustic potash. The elaterin crystallizes out as the solution cools, while the liquid holds the greenish resinous impurities. Most of the crude *Elaterium* comes from Malta.

**Description.**—In minute, colorless and odorless white scales or prismatic crystals, insoluble in water and possessing a bitter acrid taste.

**Constituents.**—An inert lævorotatory principle called  $\alpha$ -elaterin and a physiologically active, dextrorotatory, drastic cathartic principle called  $\beta$ -elaterin.

**Use.**—Powerful hydragogue cathartic in dropsies.

**Average Dose.**—0.003 Gm. ( $\frac{1}{20}$  grain).

## CAMPANULACEÆ (BLUEBELL FAMILY)

Herbs of annual or more commonly perennial growth, rarely sub-shrubby or sub-woody in habit, frequently with laticiferous tubes containing a milky juice. Inulin occurs in place of starch in the species investigated. Calcium oxalate is absent. Stem upright or feeble and spreading. Leaves alternate, simple, exstipulate. Inflorescence primitively a racemose cyme, condensing into a raceme, to a sub-capitulum and ultimately to a capitulum. Flowers regular, campanulate to campanulate-elongate to elongate and deeply cleft in petals; sepals five, only slightly synsepalous, epigynous; petals five, campanulate to campanulate-tubular to tubular-elongated to tubular and deeply cleft; corolla varying in color from greenish-yellow to yellowish-white to white or again, from yellowish-purple (rarely through yellowish-pink or red) to purple to pure blue; stamens five, epigynous, usually free from corolla; nectary epigynous; pistil usually tricarpellary; ovary as many celled as number of carpels and with central placenta; style single, elongate; stigmas as many as carpels.

Fruit a capsule. Seeds albuminous. Glandular hairs are absent. The non-glandular hairs are unicellular.

**Lobeliaceæ or Lobelia Family.**—Herbs, with inulin and latex contents, the latter occurring in laticiferous vessels, which ramify through cortex, phloem, xylem and pith, corresponding with *Campanulaceæ* in their vegetative parts, but differing from that group by having irregular flowers (pale blue in *Lobelia inflata*), anthers always synantherous and pistil always bicarpellate with a two-celled ovary and bilobed or bilabiate stigma.

#### LOBELIA N.F. (LOBELIA)

**Synonyms.**—*Indian-tobacco*, Wild Tobacco, Bladder Podded Lobelia, Asthma or Emetic Weed; *Ger.* Lobelienkraut; *Fr.* Herbe de lobélie enflée.

**Botanical Origin.**—*Lobelia inflata* Linné.

**Part Used.**—The dried leaves and tops.

**Purity Rubric.**—Not more than 10 per cent. of its stems nor more than 4 per cent. of other foreign organic matter. It yields not more than 5 per cent. of acid-insoluble ash.

**Habitat.**—In open woods and meadows of United States and Canada east of the Mississippi.

**Plant.**—An annual herb with an erect, yellowish-green, pubescent, branched stem from .3 to .6 m. in height. The leaves are alternate, ovate or oblong with serrate denticulate margins, the lower short-petioled, the upper sessile. The inflorescences are terminal racemes of small, pale blue, short pedicelled flowers. The fruits are bladdery, ovoid or ellipsoidal, 2-celled capsules containing numerous small, oblong, coarsely reticulate, brown seeds.

**Description.**—Stems cylindrical, winged and coarsely and irregularly furrowed, yellowish-green, occasionally purplish and with numerous hairs; leaves alternate, sessile or short petiolate, usually somewhat broken; when entire, laminae pale olive to dusky yellowish green, pubescent with scattered, bristly hairs, ovate or oblong, from 2 to 9 cm. in length, obtusely dentate or irregularly serrate-denticulate, each tooth with a yellowish-brown, glandular apex; flowers pale blue, in elongated loose racemes; calyx tube ovoid, with 5 subulate teeth, corolla tubular, from 3 to 4 mm. in length, 5 parted, the upper 2-lobed portion cleft nearly to the base; stamens with anthers united above into a curved tube enclosing the bifid stigma; capsules bladdery, ovoid or ellipsoidal, from 5 to 8 mm. in length, light-brown, inferior, and enclosing numerous brown, oblong and coarsely reticulate seeds; odor slight; taste strongly acrid and tobacco-like.

**Production and Commerce.**—The drug is obtained from both wild and cultivated plants. When cultivated, the seeds should be sown in the fall or spring in rows about 2 feet apart. The soil should be rich loam which has been made very fine before sowing. The seeds are best sown on the surface of the soil and the ground then made firm by placing a board over the row and walking upon it. Shallow cultivation is necessary. About 1000 pounds of drug per acre can be harvested. Most of the drug is obtained from plants grown in Massa-

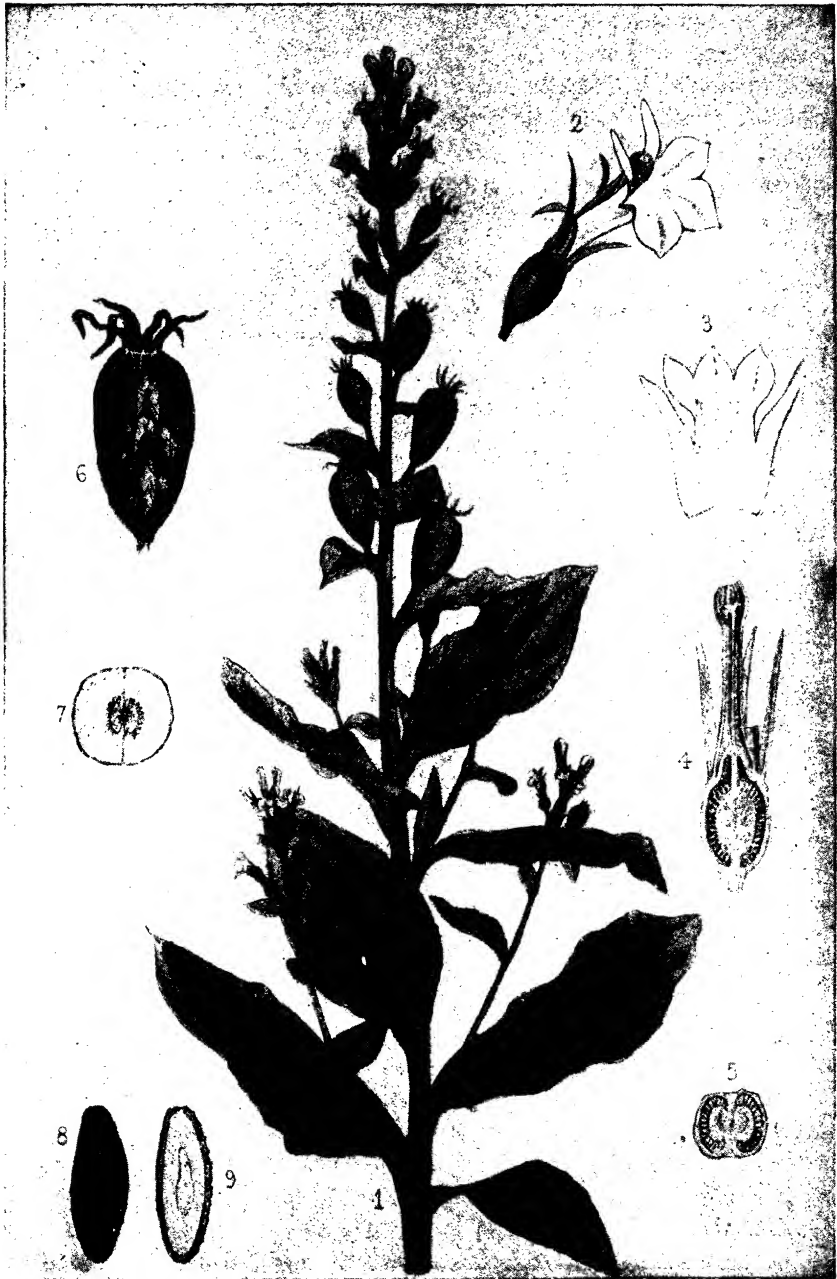


FIG. 457.—*Lobelia inflata*. 1. Upper part of plant. 2. Flower. 3. Corolla. 4. Vertical section of flower with corolla cut off. 5. Transverse section of ovary. 6. Ripe fruit. 7. Transverse section of fruit. 8. Seed. 9. Vertical section of same. (After Bentley and Trimen.)

chusetts, New York and Michigan. The leaves and flowering tops are collected after a portion of the capsules have become inflated and carefully dried in the shade.

**Powdered Drug.**—Dusky yellow to weak greenish-yellow; odor slight and irritating; taste strongly acrid; fragments of seed coat composed of somewhat elongated polygonal cells with thick yellowish brown walls; fragments of stem with tracheæ showing annular or spiral thickenings or simple pores associated

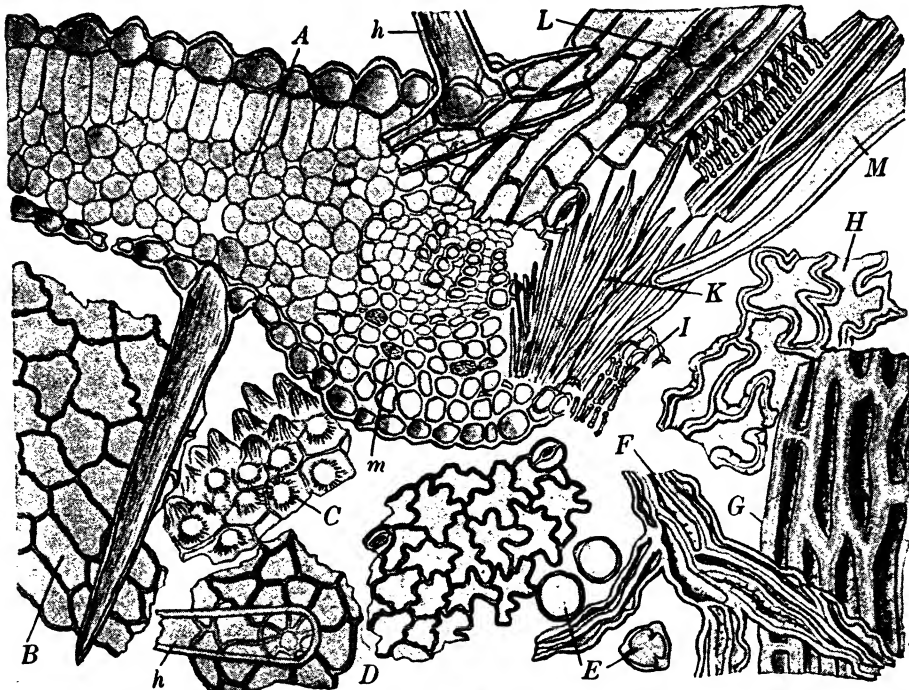


FIG. 458.—*Lobelia*. A, Cross section of the leaf with a portion of the midrib and with latex vessels in the latter *m*; B, upper epidermis of leaf in surface view; C, corolla margin with papillose epidermal cells; D, 2 portions of the lower leaf epidermis, the left with hair *h* (surface view); E, pollen grains; F, sclerenchyma fibers from a fibrovascular bundle of the pericarp; G, seed epidermis in surface view; H, epicarp of capsule in surface view; I, endothecium; K, connective apex; L, vascular bundle with fibers and tracheæ from the stem with overlying epidermis (to left); M, corolla hair with rounded end.  $\times 300$ . K, less enlarged. (After Wasicky.)

with narrow, thin-walled, wood fibers; fragments of leaf epidermis with elliptical stomata up to  $35\mu$  in length and with usually 3 to 4 neighboring cells; fragments of pericarp of capsule with lignified sclerids; fragments of mesocarp of capsule showing stellate cells; occasional nonglandular hairs, unicellular, short and pointed or elongated to elongated-conical with rounded distal end and up to 1.11 mm. in length; spheroidal pollen grains from 20 to  $30\mu$  in diameter; fragments of epicarp of capsule with thick, sinuous walled cells.

**Constituents.**—The poisonous acrid alkaloid, *lobeline*, the alkaloids *lobelanine*, *lobelanidine* and *isobobelanine*; lobelic acid, lobelacrin, inflatin, resin, fixed oil, volatile oil (lobelianin), etc.

**Uses.**—Expectorant in asthma and chronic bronchitis.

**Average Dose.**—0.1 Gm. ( $1\frac{1}{2}$  grains).

**Preparations.**—Lobelia Fluidextract, 0.1 cc. ( $1\frac{1}{2}$  minims); Lobelia Tincture, 1 cc. (15 minims).

### COMPOSITÆ (DAISY FAMILY)

Herbs, of annual, biennial or perennial habit, rarely shrubs or trees, and with watery or milky juice, the latter occurring in laticiferous vessels. Inulin is present in cell sap of parenchyma. Schizogenous oil and resin reservoirs occur in a number of genera. Leaves alternate, rarely opposite, simple and entire or toothed to compound, exstipulate. Inflorescence a capitulum or a raceme or corymb of capitula, each capitulum surrounded by an involuere or protective whorl of bracts, and composed of numerous florets that may be: (a) wholly regular, tubular and hermaphrodite (Thistle, Eupatorium, Burdock, Artemisia, Tansy, etc.); or (b) central florets as in (a), but marginals strap-shaped or ligulate and usually pistillate (Daisy, Chrysanthemum, Arnica, Dahlia, Chamomile, etc.); or (c) florets all ligulate and hermaphrodite (Dandelion, Chicory, Hawkweeds, Lettuce, etc.); or (d) florets in part or in whole bilabiate (Mutisia, etc.). Flowers small (florets), closely crowded, pentamerous, shaped as above, with ovary inferior and other floral parts superior. Sepals rudimentary, tooth-like (Sunflower), or reduced to a pappose or hairy rudiment above ovary that is functionless during flowering, but that expands in fruit as a hairy fruit disseminator (Dandelion, Thistle, etc.); or sepals wholly absorbed (Daisy). Petals synpetalous, tubular, ligulate or rarely bilabiate, greenish-yellow to white, or through pink-crimson and purple to blue (Chicory). Stamens five, epipetalous, filaments distinct, anthers united into an upright anther-box (so synantherous) into which pollen is shed before or during the opening of each floret. Carpels two, syncarpous; ovary inferior, one-celled with single ovule; style simple, at first short, later elongating and by collecting hairs sweeping pollen to top of anther box, then dividing into two stigmatic surfaces with stigmatic hairs for pollen reception. Fruit an indehiscent achene, often (Arnica, Thistle) crowned by the pappose calyx rudiment (*pappus*) which may be in the form of teeth, bristles, hairs or awns. Seed single, exalbuminous. Pollen grains spinose.

### MATRICARIA N.F. (MATRICARIA)

**Synonyms.**—*German Chamomile, Hungarian Chamomile, Wild Chamomile; Ger. Kamillen; Fr. Fleurs de Chamomille commune.*

**Botanical Origin.**—*Matricaria Chamomilla* Linné.

**Part Used.**—The dried flower-head.

**Purity Rubric.**—Not more than 10 per cent. of the stems of the plant and not more than 2 per cent. of other foreign organic matter. It yields not more than 4 per cent. of acid-insoluble ash.

**Habitat.**—Europe and Western Asia.

**Plant.**—A branched annual herb attaining a height of about 0.6 m. bearing alternate, tripinnately-divided leaves below and bipinnately divided leaves above, both types having almost filiform lobes. The flower heads show a



FIG. 459.—*Matricaria Chamomilla* L., the German or Hungarian Chamomile.  $\times \frac{1}{2}$ .

conical, hollow receptacle surrounded by a flattened imbricated involucre, white ligulate florets and yellow tubular florets, the pappus being absent.

**Production and Commerce.**—The plant grows wild in this country and Europe but is also cultivated in gardens. It is propagated from seeds which

may be sown broadcast in moderately heavy moist soil, rich in humus. The plants bloom in about 2 months after sowing the seed, so that it is possible in many sections to obtain 2 crops a year. The flower heads are gathered when plants are in full bloom, leaves and stems removed, and dried on canvas sheets in the sun. They are then packed in cases or bales for the market. The commercial supplies have been largely obtained from Argentina, Hungary, Belgium, Russia, Poland and Germany. Some recent supplies have also arrived from



FIG. 460.—*Anthemis Cotula*, the heads of which have frequently been admixed with *Matricaria*.

Colombia. Siftings consisting of ray and disk florets are also imported, though not official.

**Description.**—Flower heads composed of a few white ligulate florets and numerous yellowish-orange to pale yellow tubular or disk florets on conical, hollow receptacles the latter being up to 10 mm. in breadth; disk or tubular florets perfect and without a pappus; ray or ligulate florets from 10 to 20, pistillate; corolla white, 3-toothed and 4-veined; involucre hemispherical, composed of from 20 to 30 imbricate, oblanceolate and pubescent scales; peduncles weak brown to dusky greenish yellow, longitudinally furrowed, more or less twisted



and up to 2.5 cm. in length; achenes more or less obovoid and faintly 3- to 5-ribbed; pappus none, or only a slight membranous crown; odor characteristically and fragrantly aromatic; taste aromatic and bitter.

**Powdered Drug.**—Moderate yellowish-brown to light olive-brown; fragments of corolla from ligulate florets with papillate epidermal cells, some epidermal cells of corolla with short-stalked, glandular hairs; numerous spinose, spherical or somewhat triangulate pollen grains up to  $25\mu$  in diameter with prominent conical projections of outer wall and 3 pores; papillose fragments of stigmas the upper end bearing papillæ; fragments of collapsed parenchyma; fragments of fibrovascular bundles with spiral, annular and reticulate tracheæ and sclerenchyma fibers; fragments of involucre bracts with epidermis having elliptical stomata up to  $30\mu$  in length, also tracheæ and fibers; fragments of

DISTINCTIONS BETWEEN FLOWER HEADS OF MATRICARIA, ANTHEMIS COTULA AND ANTHEMIS NOBILIS

Part	Matricaria	Anthemis Cotula	Anthemis nobilis (wild plant)
Receptacle Flower head	Hollow Ovoid becoming conical	Solid Decidedly conical to oblong	Solid Conical
Peduncle	Unicellular non-glandular hairs absent	Numerous unicellular non-glandular hairs	Numerous unicellular non-glandular hairs
Paleæ (scales on receptacle)	Absent	Present. Broad and membranous	Present. Broad and bristly acuminate
Ligulate florets	Pistillate, 3 toothed and 4 veined; 10-20 in one series	Neutral, mostly 3 toothed; 10-18 in one series	Pistillate, 3 toothed, 3 to 6 veined; 12-18 in one series
Bracts	Entire, lanceolate	Fimbriated, obovate	Obtuse, pubescent, with scarious margins
Achenes	Smooth, 3-5 ribbed	Rough, 10-ribbed	Oblong, obtusely 3-angled
Pappus	Absent or as toothed membrane	Absent	Absent

achene tissue with epidermal cells having scalariform markings or wavy longitudinal walls, and parenchyma containing rosette aggregates of calcium oxalate, the latter up to  $10\mu$  in diameter; fragments of characteristic tissue of anthers composed of elongated cells with scalariform walls.

**Constituents.**—*Volatile oil* of a blue color due to *azulene* and containing isoamyl, isobutyl and other alcohols combined as esters with angelic and tiglic acids; *anthemic acid* (a bitter principle), tannin, malic acid, etc.

**Use.**—Aromatic bitter.

**Average Dose.**—15 Gm. (4 drachms).

**Adulterants.**—(1) The flower heads of *Anthemis Cotula* L., commonly known as Mayweed, Fetid Chamomile or Dog Fennel, an annual glabrous

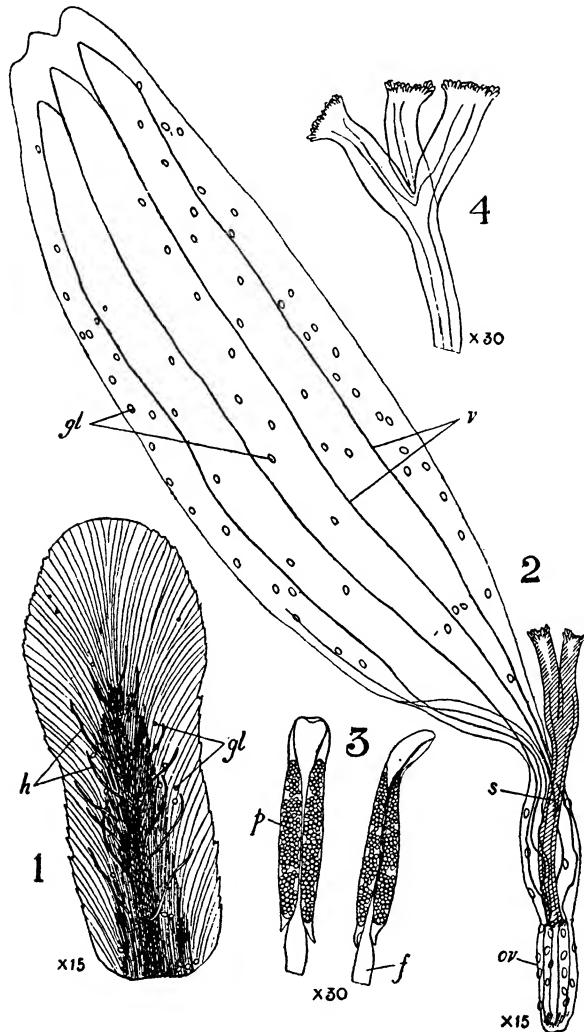


FIG. 461.—English or Roman Chamomile. 1, Involucre bract,  $\times 15$ . 2, Ligulate floret  $\times 15$ . 3, Stamens from a tubular floret  $\times 30$ . 4, Trifid stigma of a tubular floret, showing the stigmatic papillae  $\times 30$ . f, filament of stamen; gl, oil-gland; h, hair; ov, ovary; p, pollen in the anther lobe; s, style; v, veins of the ligulate corolla. (From "*Materia Medica*" by Greenish.)

herb with a disagreeable fetid odor. It is widely distributed over lower Canada and United States, having been naturalized from Europe.

(2) The flower heads of wild plants of *Anthemis nobilis* L., a perennial, pubescent, procumbent herb indigenous to Europe but naturalized in most of the northeastern states.

(3) Flower heads of *Santolina chamæcyparissus* L., or Garden Cypress have been detected by Clevenger and Ewing in a shipment of *Matricaria* from Spain. These differ from *Matricaria* in their absence of ligulate florets, in the recurving of the tubular florets and in their solid chaffy receptacle, the chaffy scales being very broad with rounded summits.

(4) *Matricaria* stems.



FIG. 462.—*Grindelia squarrosa* (Pursh) Dunal.  $\times \frac{1}{2}$ .

**Allied Drug.**—English or Roman Chamomile consists of the dried flower head of cultivated plants of *Anthemis nobilis* L. It occurs in hemispherical heads of a whitish or buff color (upon keeping) each with a solid conical receptacle bearing paleæ and numerous ligulate florets, the corollas of which possess 3 teeth and 4 veins, and subtended by an involucre of 3 rows of imbricate bracts with membranous margins. It contains up to 1 per cent. of a blue volatile oil, anthemic acid, etc. Aromatic bitter.

**Average Dose.**—15 Gm. (4 drachms).

#### GRINDELIA N.F. (GRINDELIA)

**Synonyms.**—*Grindelia Robusta*, Gum Plant; *Ger. Grindellie*; *Fr. Grindelia*.

**Botanical Origin.**—(1) *Grindelia camporum* Greene, (2) *Grindelia humilis* Hooker and Arnott and (3) *Grindelia squarrosa* (Pursh) Dunal.

**Part Used.**—The dried leaves and flowering tops.

**Purity Rubric.**—Not more than 10 per cent. of its stems over 2 mm. in diameter and not more than 2 per cent. of other foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—Western North America.

**Plants.**—Perennial herbs with branched stems bearing alternate sessile or clasping, oblong to oblong-spatulate, serrate to dentate, pale green leaves

TABLE OF COMPARISON BETWEEN OFFICIAL GRINDELIAS

Part	<i>Grindelia camporum</i>	<i>Grindelia humilis</i>	<i>Grindelia squarrosa</i>
Stem	Cylindrical, pinkish to yellowish, with attached, alternate branches and small nodes	Cylindrical, pinkish to purplish-brown, with attached alternate branches and larger nodes	Cylindrical, grayish-green to yellowish, with alternate branches and larger nodes
Leaves	Sessile and clasping	Sessile and clasping	Sessile and clasping
Leaf outline	Oblong to oblong spatulate	Oblong to cuneate oblong	Oblong
Leaf apex	Acute	Acute	Obtuse
Leaf base	Subcordate	Subcordate	Subcordate
Leaf margin	Irregularly serrate	Entire below, serrate above, ciliate	Dentate
Upper surface	Pale green, shiny and resinous	Light green to greenish brown and pitted	Gray green or yellowish to orange-green, resinous
Lower surface	Paler green, resinous	Pale green and devoid of resin	Grayish-green, resinous
Length of leaf	Up to 6 cm.	Up to 9.8 cm.	Up to 5 cm.
Breadth of leaf	Up to 15 mm.	Up to 27 mm.	Up to 15 mm.
Involucral bracts	Linear lanceolate, imbricate, resinous with recurved tips	Linear lanceolate, imbricate, resinous with recurved tips	Linear lanceolate, resinous, imbricate with recurved tips
Ligulate florets	Orange brown, pistillate	Yellow, pistillate	Yellow, pistillate
Tubular florets	Yellow, perfect	Yellow, perfect	Yellow, perfect
Achenes	4-angled with biauriculate summit	4-angled, toothed, with biauriculate summit	4-angled, not toothed, truncate at summit
Odor	Balsamic	Balsamic	Balsamic
Taste	Aromatic and bitter	Aromatic and bitter	Aromatic and bitter

and large resinous flower heads containing both ligulate and tubular, yellow flowers. The involucre of each flower head is hemispherical and consists of several series of slender bracts which are imbricated and with recurved tips. The fruits are short, truncate, glabrous achenes. The pappus consists of two or three, mostly unequal linear awns which usually fall before the achene has completely matured.

**Production and Commerce.**—The leafy tops of the *Grindelia* plants are cut off in July and carefully dried in the sun. The present commercial supply of the drug chiefly comes from the southwestern section of the United States.

**Powdered Drug.**—Light yellowish brown to yellow. Numerous fragments of fibrovascular bundles showing lignified wood fibers and annular, spiral and simple or bordered pored tracheæ; numerous fragments of pith parenchyma the cells of which contain a layer of protoplasm in which spheroidal granules are



FIG. 463.—*Artemisia Absinthium* L. Leaves and flowering tops which constitute the drug.  $\times \frac{1}{2}$ .

imbedded; spherical spinose pollen grains up to  $35\mu$  in diameter; fragments of mesophyll; fragments of leaf epidermis with colorless basal cells of glandular hairs, the glandular hairs having the multicellular heads up to  $100\mu$  in diameter, each cell of which contains a rosette of crystals up to  $8\mu$  in diameter.

**Constituents.**—*Resins*, *grindeline* (alkaloid), tannic acid, *volatile oil*, etc.

**Uses.**—Grindelia is used as a stimulating expectorant in bronchitis and often smoked with stramonium and other drugs in asthma. Its aqueous fluid-extract is diluted with water and used locally for poison ivy dermatitis.

**Average Dose.**—2 Gm. (30 grains).

**Preparation.**—Grindelia Fluidextract, N.F., 2 cc. (30 minims); Aqueous Fluidextract of Grindelia.

#### ABSINTHIUM (ABSINTHIUM)

**Synonyms.**—Wormwood, Absinth, Maderwort, Mugwort, Mingwort; *Fr.* Absinthe grande; *Ger.* Wermut, Alseikraut, Magenkraut, Bitterkraut.

**Botanical Origin.**—*Artemisia Absinthium* Linné.

**Part Used.**—The dried leaves and flowering tops.

**Habitat.**—Europe, Asia and Northern Africa.

**Plant.**—A shrubby, odorous, grayish-green, finely canescent herb with branched stem attaining a height of about 1 m. Its leaves are once, twice or thrice pinnately-divided into many obovate or linear lobes, the lower, long petioled and the upper, short petioled or sessile. The inflorescence consists of racemose-paniculate heads, drooping on short pedicels. Each head is greenish-yellow, round ovoid and composed of tubular florets inserted on a pubescent receptacle which is subtended by a hemispherical involucre of imbricated bracts.

**Production and Commerce.**—The plant is extensively cultivated in various parts of Europe mainly for flavoring beer and for the manufacture of a liquor termed "absinthe." It is also cultivated in various sections of the United States and some of the commercial article is gathered in Michigan, Wisconsin and New York. The leaves and flowering tops are gathered in August and September, dried and stored in tin containers. The foreign commercial supplies to this country come largely from France and Italy.

**Description.**—Stems and leaves gray-green, silky hairy and glandular throughout; the largest leaves 10 to 12 cm. in length and of almost equal breadth, 2- to 3-pinnately lobed or divided, the ultimate segments oblong or obovate, obtuse, entire or slightly toothed; upper leaves becoming gradually shorter petioled, small and narrower, the uppermost only about 2 cm. long and resembling the ultimate segments of the larger lower ones; heads greenish-yellow, racemose-paniculate, from 3 to 4 mm. in breadth, globose-ovoid, with a hemispherical involucre of bracts, outer bracts linear-oblong, obtuse; inner bracts broader and with membranous margins; receptacle pilose-hairy; florets all tubular; odor characteristically aromatic; taste very bitter.

**Powdered Drug.**—Brownish-green or yellowish-green; numerous whole or broken T-shaped non-glandular hairs from bracts, consisting of a short, 1- to 4-celled stalk and a single apical cell attached to near center and up to 800 $\mu$  in length; long, unicellular, non-glandular hairs from florets; glandular hairs consisting when entire of a 1- to 2-celled stalk and a 4- to 8-celled head; fragments of epidermis with elliptical stomata; fragments of mesophyll; tracheæ with spiral markings or simple pores; few lignified sclerenchyma fibers; pollen grains

spheroidal, up to  $30\mu$  in diameter; rosette aggregates of calcium oxalate about  $10\mu$  in diameter.

**Constituents.**—*Volatile oil* containing *absinthol*, a bitter glycoside termed *absinthin*, tannic acid, resin, etc.

**Uses.**—Aromatic bitter, diaphoretic and flavoring agent.

**Average Dose.**—2 Gm. (30 grains).

**Allied Product.**—*Tarragon* or *Artemisia Dracunculus* L., a perennial herb native to Russia and northern Asia and cultivated in gardens in the U.S. and France, yields a volatile oil containing *methyl chavicol* or *estragol*, *phellandrene* and *ocimene*. It possesses linear to narrowly lanceolate, sessile leaves which exhibit bifacial structure and panicles of small, globular, greenish-white flower heads. Both the stem and the midrib of the leaves contain an interrupted row of oleoresin ducts in the pericycle. The leaves, tender stems and oil are used as seasoning agents for tarragon vinegar, salads, sauces and pickles.

#### CALENDULA (CALENDULA)

**Synonyms.**—Marigold, Garden Marigold; *Ger.* Ringelblumen; *Fr.* Fleurs de tous les mois, Fleurs de souci.

**Botanical Origin.**—*Calendula officinalis* Linné.

**Part Used.**—The dried ligulate floret.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash. N.F. VII.

**Habitat.**—Mediterranean Basin and Southern Europe.

**Plant.**—An annual herb frequently found in gardens as an ornamental plant. Its stem is angular and hairy, grows to the height of 0.4 to 0.6 m. and bears oblanceolate to spatulate leaves with toothed margins. Its flower heads are terminal about 5 cm. in breadth. Each consists of yellow to orange ray and disk florets.

**Production and Commerce.**—*Calendula* is cultivated widely as a garden ornamental in this country and Europe. It thrives best in moderately rich garden soil. The seeds should be sown in drills about  $1\frac{1}{2}$  feet apart in the spring. As soon as the seedlings are sufficiently strong they should be thinned so as to stand about one foot apart. The plants bloom throughout the summer. The flower heads should be collected when fully expanded, the ligulate florets removed by hand and carefully dried. Some of the drug is produced in this country but most of it is imported from Spain, France and Italy.

**Description.**—Ligulate florets from 15 to 25 mm. in length, more or less shrivelled, yellow- to moderate orange-colored, the limb 1- to 3-toothed, 4- or 5-veined, the short hairy tube occasionally enclosing the remnants of a filiform style and bifid stigma; odor slight; taste slightly bitter.

**Histology.**—Fragments of the corolla, mounted in water or chloral hydrate T. S., exhibit elongated epidermal cells with striated cuticle, the parenchyma cells beneath showing numerous, often yellow, oil globules and irregular chromoplastids. In the vicinity of the tube will be noted a few long non-glandular hairs, consisting of a double row of thin walled, more or less collapsed cells, with

a 1- to 2-celled summit, and up to about  $950\mu$  in length. Coursing through the mesophyll will be noted strands of fibrovascular tissue, each possessing annular and spiral tracheæ. Spinose pollen grains, 3 pored, and up to  $45\mu$  in diameter will be noted adhering to the corolla.

**Constituents.**—*Volatile oil, bitter principle, resin and calendulin (a tasteless gummy principle).*

**Use.**—Calendula is employed chiefly in the form of its tincture as a vulnerary. It is occasionally used internally as an aromatic bitter.

**Average Dose.**—1 Gm. (15 grains).

**Preparations** (unof.).—Fluidextractum Calendulæ, 1 cc.; Tinctura Calendulæ, 4 cc.

**Adulterants.**—Ligulate florets of various species of the *Compositæ*.

#### ARNICA N.F. (ARNICA)

**Synonyms.**—*Arnica Flowers, European Arnica, American Arnica, Wolf's Bane, Mountain Tobacco, Leopard's Bane; Ger. Arnikablüthen, Fallkraut; Frs. Fleurs d'Arnique.*



FIG. 464.—*Arnica montana*. Flower head and upper portion of flowering stem. Natural size. (From Greenish, "Materia Medica".)

**Botanical Origin.**—*Arnica montana* Linné (European Arnica), *Arnica fulgens* Pursh, *Arnica sororia* Greene, and *Arnica cordifolia* Hooker (American Arnica).

**Part Used.**—The dried flower head.

**Purity Rubric.**—Not more than 3 per cent. of foreign organic matter and not more than 2 per cent. of acid-insoluble ash.



**Habitat** of *A. montana*—In mountains and meadows of Europe, of *A. fulgens*, *A. sororia* and *A. cordifolia*—western North America.

**Plants** *A. montana* L. is a perennial herb flourishing in the Alps and Pyrenees of Europe.

Its underground portion consists of a rhizome of horizontal growth up to 10 cm. in length and up to 5 mm. in diameter, showing in its anterior region annulations from the scars of previous years' leaves and remnants of last year's leaves and on its lower surface many coarse wiry rootlets. Its thick bark contains an interrupted circle of schizogenous oleoresin reservoirs.

Its overground portion consists of a basal rosette of entire oblanceolate leaves up to 17 cm. in length with 5 to 7 nerves from the center of which projects an erect, simple, glandular hairy stem up to 6 dm. in height which bears from 2 to 4 pairs of cauline leaves of ovate, elliptic-oblong, lanceolate or oblanceolate outline with rounded or rounded-toothed apex and clothed with numerous non-glandular and glandular hairs, up to 16 cm. in length and up to 5 cm. in width. From the uppermost pair of cauline leaves extend 1 to 3 peduncles bearing alternate bracteoles. These are glandular-puberulent, each terminating in a hemispherical or turbinate capitulum up to 6 or 8 cm. in breadth bearing orange-yellow flowers. The fruit is a spindle-shaped achene from 5 to 7 mm. in length.

The American Arnica yielding Arnica are perennial herbs with horizontal rhizomes, containing schizogenous oleoresin reservoirs, puberulent, glandular hairy stems and leaves and possess a somewhat similar growth habit to *A. montana*. *Arnica fulgens* or Orange Arnica is characterized by the dense tufts of long tawny hairs in the axils of the bases of previous years' leaves, by its hemispherical heads of dark orange to orange-yellow florets and oblong-conical to fusiform achenes, up to 5.5 mm. in length. *A. sororia* shows few or no tufts of hairs in the old radical leaf axils, hemispherical flower heads of yellow florets and oblong conical, longitudinally ridged achenes up to 5 mm. long. *A. cordifolia* or Heart Leaf Arnica is characterized by its petiolate, cordate to ovate basal leaves, turbinate to campanulate flower heads of yellow florets, oblong to slenderly fusiform achenes up to 6 mm. in length, and by its bract margins which are irregularly toothed to lacinate. For further details on these plants and their flower heads see "A Pharmacognostical Study of European and American Arnica" by Youngken and Wirth, *J. Am. Pharm. Assoc., Sci. Ed.*, 34: 65, 1945.

**Production and Commerce.**—European Arnica is collected from plants growing wild in mountain meadows and upland moors of central Europe. Both rhizomes and flower heads are used in medicine. The flower heads are collected when fully expanded, and should be deprived of their receptacles and involucre and dried. The receptacles with investing involucre often contain the eggs and larvæ of the Arnica fly, *Trypeta arnicivora*. The European article has been imported from Belgium, France, Germany, Italy and Yugoslavia. American Arnica is collected from wild plants growing in the western Rocky Mountain districts chiefly in the states of Montana and Wyoming.

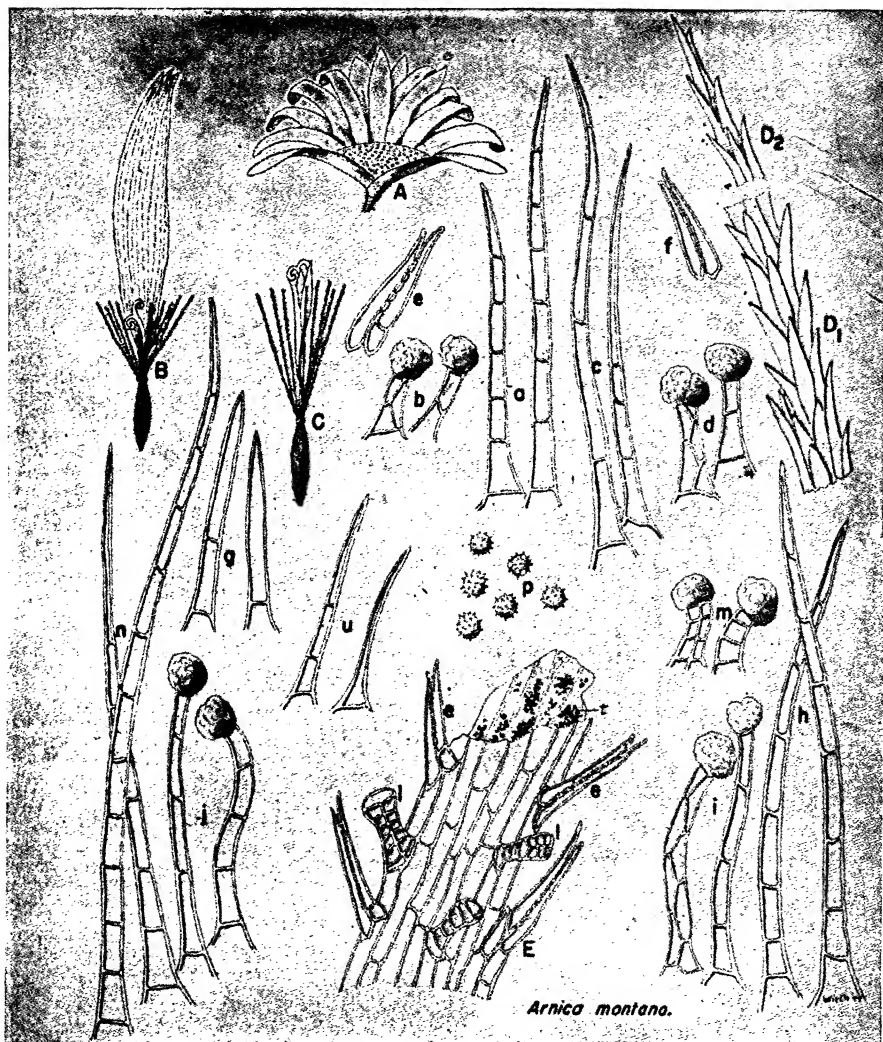


FIG. 465.—European Arnica (*Arnica montana* L.). Parts of the flower head. A, receptacle with bracts; B, ligulate floret; C, tubular floret; D<sub>1</sub>, pappus, lower portion; D<sub>2</sub>, pappus, apical portion; E, surface fragment, ligulate achene; a, nonglandular hair, ligulate corolla; b, glandular hair, ligulate corolla; c, nonglandular hair, tubular corolla; d, glandular hair, tubular corolla; e, double hair, ligulate achene; f, double hair, tubular achene; g, nonglandular hair, receptacle; h, nonglandular hair, bract; i, glandular hair, bract; j, glandular hair, peduncle; l, glandular hair, ligulate achene; m, glandular hair, tubular achene; n, nonglandular hair, peduncle; p, pollen grains; t, phytomelane; u, nonglandular hair, tubular achene. Receptacle,  $\times 1.15$ ; Ligulate and tubular florets,  $\times 2.3$ ; all other elements,  $\times 77$ . (After Youngken and Wirth, *Jour. A. Ph. A.* 34 (1945) 68).

**Description.**—Arnica occurs as entire flower heads or as tubular and ligulate florets with few (European Arnica) to many (American Arnica) receptacles and involucre; heads hemispherical, turbinate or campanulate; receptacle flat to slightly convex (*Arnica montana*) or prominently convex (American Arnica),

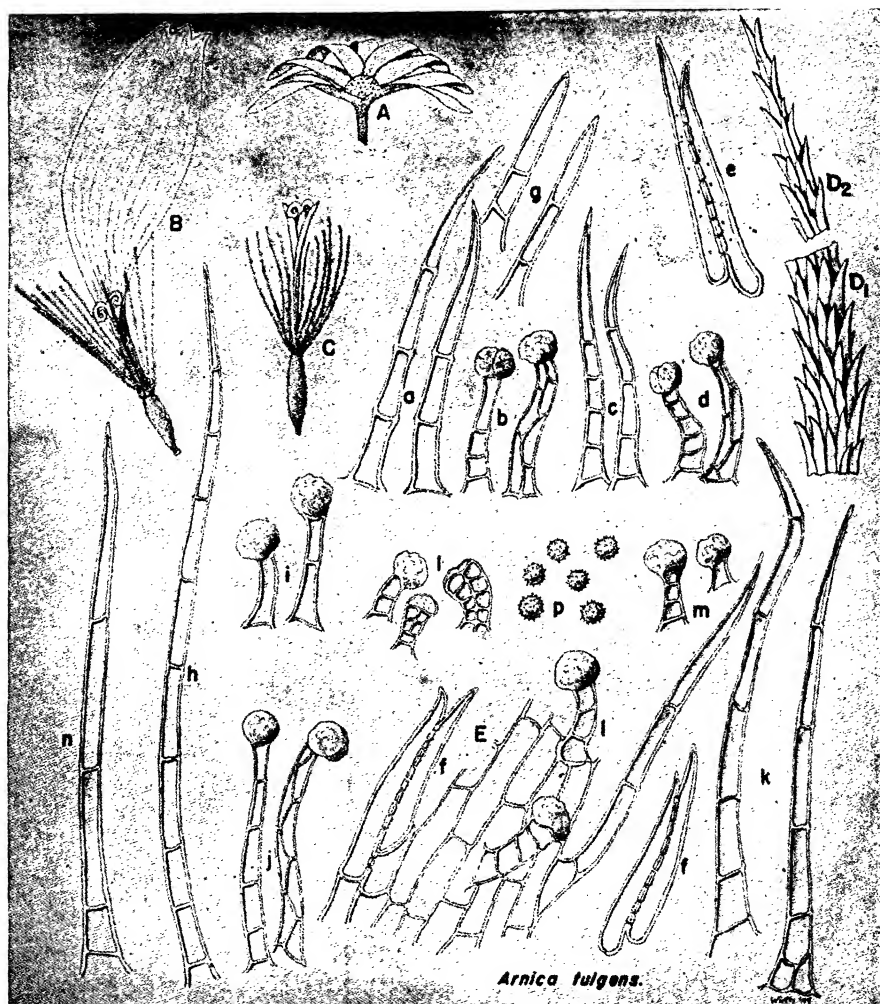


FIG. 466.—An American Arnica, *Arnica fulgens* Pursh. Parts of the flower head. A, receptacle with bracts; B, ligulate floret; C, tubular floret; D<sub>1</sub>, pappus, lower portion; D<sub>2</sub>, pappus, apical portion; E, surface fragment, ligulate achene; a, nonglandular hair, ligulate corolla; b, glandular hair, ligulate corolla; c, nonglandular hair, tubular corolla; d, glandular hair, tubular corolla; e, double hair, ligulate achene; f, double hair, tubular achene; g, nonglandular hair, receptacle; h, nonglandular hair, bract; i, glandular hair, bract; j, glandular hairs, peduncle; k, marginal nonglandular hairs, receptacle; l, glandular hair, ligulate achene; m, glandular hairs, tubular achene; n, nonglandular hair, peduncle; p, pollen grains; Receptacle,  $\times 1.15$ ; Ligulate and tubular florets,  $\times 2.3$ ; all other elements,  $\times 77$ . (After Youngken and Wirth, *Jour. A. Ph. A.* 34 (1945), 69).

deeply pitted, and covered with short hairs; involucre bracts lanceolate to elliptic-oblong, those of *Arnica cordifolia* being frequently toothed or lacinate along the margins, light olive green to weak reddish brown, puberulent and glandular hairy, up to 25 mm. in length and from 1 to 3.5 mm. in width; ligulate florets yellow to moderate orange, pistillate, their corollas being up to 27 mm. in

length and up to 6 mm. in width, the ligula being usually 3-toothed and 7 to 12 nerved; tubular florets perfect, goblet-shaped, yellow to yellowish orange, their stamens bearing 2-oblong-elliptic anther lobes united by an elongated triangular connective; achenes oblong to spindle-shaped, appressed-hispid, longitudinally striate or glandular dotted, 3.5 to 7 mm. in length, brownish gray to light olive brown, with a collar near the summit bearing a single circle of barbellate bristles; odor characteristic, agreeable; taste bitter and acrid.

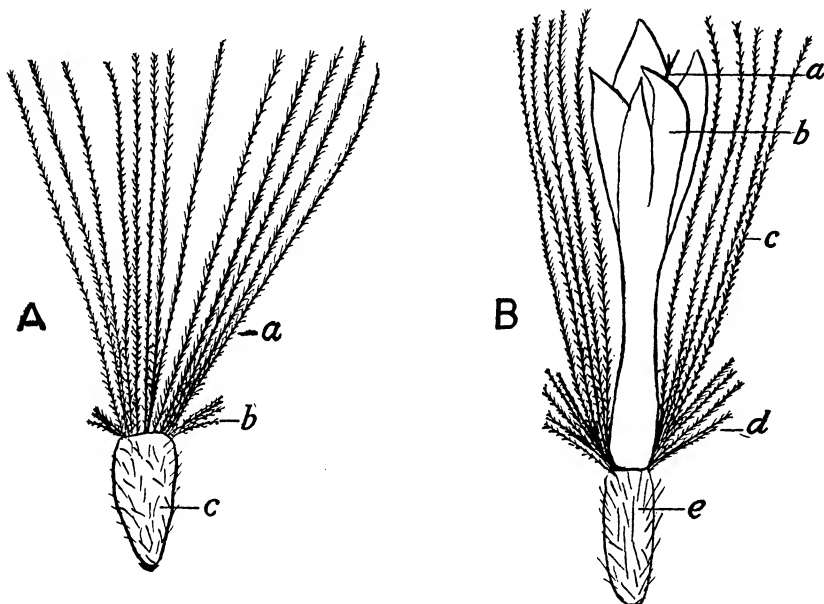


FIG. 467.—A, Fruit of *Heterotheca inuloides*, an arnica adulterant. Inner, long pappus (a); outer, short pappus (b); akene (c). B, Tubular floret of *Heterotheca inuloides*. Style (a); corolla (b); inner long pappus (c); outer, short pappus (d); ovary (e).

**Powdered Drug.**—Light yellowish brown to light olive-brown; pollen grains numerous, spheroidal and spinose, 25 to 40 $\mu$  in diameter; non-glandular hairs of the following kinds: unicellular and uniseriate-articular, straight, curved or dagger-shaped, the uniseriate hairs up to 9-celled, rarely 11-celled, some with short basal cells and elongated distal cell, and double hairs, the latter up to 384 $\mu$  in length, mostly unequal in length of parts, with bifid summits, each with numerous pores on the dividing wall separating the two components, one of which is either 1- or 2-celled; glandular hairs of the following kinds: with a unicellular stalk and a 1- to 2-celled head, with a uniseriate or biseriate stalk and a 1-, 2-, or 4-celled head; pappus bristles possessing a multicellular axis and unicellular branches.

**Constituents.**—*Arnica* (a yellow crystalline bitter principle); up to 0.14 per cent. of *volatile oil* containing the dimethyl ether of thymohydroquinone; resin; tannin, a phytosterin called arnisterin, etc.

**Use.**—The tincture is used externally as a stimulant, irritant and vulnerary in bruises and sprains.

**Average Dose** (unof.).—0.2 Gm. (3 grains).

**Preparations.**—Arnica Fluidextract, 0.1 cc. (1½ minims); Arnica Tincture, 0.5 cc. (8 minims).

**Adulterants.**—(1) The flower heads of *Inula britannica* L. which are characterized by the smaller ligulate florets with but 4 veins in each ligula, a smooth receptacle and a short achene having a length of about 1.4 mm. (2) Flower heads of *Heterotheca inuloides*. See Fig. 467 A, B.

**Allied Drug.**—*Arnica Radix* or Arnica Root represents the dried rhizome and roots of *Arnica montana*. The *rhizome* is subcylindrical, occasionally jointed, curved, up to 10 cm. in length and up to 5 mm. in diameter, externally dark brown, longitudinally or spirally furrowed, and showing in its upper portion annulations from leaf scars and hairy fibers from leaves; upper surface with stem bases or stem-scars; lower surface with numerous coarse roots; fracture short; bark thick, yellow or whitish showing an interrupted circle of oleoresin reservoirs; wood narrow with yellow wedge-shaped xylem patches and broad medullary rays; pith large, whitish. *Roots* numerous, brownish, curved and twisted, wiry and up to 1 mm. in thickness with a short, hard fracture, the fractured surface exhibiting a thick whitish bark with an interrupted circle of oleoresin reservoirs and a yellow wood. Odor aromatic; taste bitter and acrid.

Arnica root contains up to 0.5 per cent. of *volatile oil*; *arnicin*, tannin and inulin. It is used for the same purposes as arnica flowers.

#### PYRETHRUM N.F. (PYRETHRUM)

**Synonyms.**—*Pyrethrum Flowers*, *Insect Flowers*; *Ger.* Bertramblüthen; *Fr.* Fleurs de pyrèthe.

**Botanical Origin.**—(1) *Chrysanthemum cinerariæfolium* (Trev.) Bocc., (2) *Chrysanthemum coccineum* Willdenow (*Chrysanthemum roseum* Web. et Mohr) and (3) *Chrysanthemum Marshallii* Aschers.

**Standard of Assay.**—Pyrethrum yields not less than 0.5 per cent of total Pyrethrins (Pyrethrin I and Pyrethrin II).

**Part Used.**—The dried flower heads.

**Limit of Impurities.**—Insect Flowers or Insect Powder should not contain more than 5 per cent. of insect flower stems (peduncles), not more than 2 per cent of other foreign matter other than stems and not more than 2 per cent. acid-insoluble ash, none of which has been purposely added.

**Habitat.**—(1) Yugoslavia. (2 and 3) Persia and Caucasus region.

**Plants.**—Perennial herbs with pinnatifid or divided leaves and hemispherical to top-shaped heads of yellow, tubular and cream colored (*C. cinerariæfolium*) or reddish (*C. coccineum*) ligulate florets.

**Production and Commerce.**—The three species yielding Insect Flowers grow best in warm localities and in ordinary manured or fertilized field or garden soil which is well drained and not too clayey. A rocky soil and a southern exposure are desirable. They may be propagated either from seeds or by the division

of old plants. When seeds are employed they should be mixed with sand and sown broadcast on the surface of the seed bed and covered thinly with soil. The bed should be only sparingly watered. In from 4 to 5 weeks after germination the seedlings should be transplanted to the field and set 9 to 12 inches apart in rows about 3 feet apart. Cultivation to remove weeds is essential. The flower heads are picked by hand or by means of a flower picker, being plucked just beneath the head, spread out in a thin layer on sheets and dried in the shade or sun. During the drying process they should be turned at least twice a day. They should be preserved in air tight, dry containers.

There are two chief commercial varieties of these flowers, viz.:

(1) Dalmatian Insect Flowers and (2) Persian or Caucasian Insect Flowers. The Dalmatian variety is obtained from plants of *C. cinerariaefolium*, cultivated along the eastern coast of the Adriatic sea (in what was formerly the Austro-Hungarian provinces of Dalmatia, Herzegovina and Croatia but which now is part of the territory of Yugoslavia); in Japan, Switzerland, Australia, British East Africa, Belgian Congo, Brazil, Philippine Islands, and California. These plants grow abundantly in Savska, Primorska and Zetska, all provinces of Yugoslavia bordering the eastern coast of the Adriatic sea from Italy to Albania and in the islands off the coast of those districts. The principal producing district of Japan is the island of Hokkaido. Honshu (the main island of Japan) produces about 25 per cent., Hokkaido about 64 per cent. of the total Japanese crop. The flower heads are dried in the sun, some lots being shipped entire, others powdered. The Persian variety is obtained from wild or cultivated plants of *C. coccineum* and *C. Marshallii* which abound in the Caucasus regions and in northern Persia and Japan. Most of the Insect flowers used in United States have been imported from Japan, British East Africa, Yugoslavia and Italy. Smaller amounts come from Brazil, the United Kingdom and Belgian Congo. During 1939, 13,569,928 pounds of insect flowers were imported into this country in compressed bales and bags.

**Description.**—Flower heads nearly hemispherical (*C. cinerariaefolium*) or flattened top-shaped (*C. Marshallii* and *C. coccineum* [*C. roseum*]), up to 20 mm. in diameter, consisting of a grayish-yellow rounded or conical receptacle subtended by a bell-shaped involucre consisting of an outer and inner series of imbricated scales and bearing up to 30 marginal, yellowish-white or straw-colored (Dalmatian) or reddish to purplish-red (Persian) pistillate, ligulate (ray) florets and a central broad disk of numerous, perfect, yellow, 5-toothed tubular florets. The outer bracts of the involucre are keeled, lanceolate, light brown on their outer and straw colored on their inner surface (*C. cinerariaefolium*) or green to greenish-brown and reddish-brown along margins (*C. Marshallii* and *C. coccineum*). The inner bracts are spatulate, somewhat longer than the outer bracts with pale scarious membranous margins (*C. cinerariaefolium*) or dark reddish-brown scarious margins (*C. coccineum*) or dark red to dusky brown margins (*C. Marshallii*). The ligula (limb) of the ligulate florets terminates in 3 short obtuse teeth, the central one usually being smaller than the other two. The tubular florets are up to about 7 mm. in length and exhibit a 5-ribbed



FIG. 468.—"Puckered" papillæ, ray floret,  $\times 290$ .



FIG. 469.—Pollen grains,  $\times 140$ .

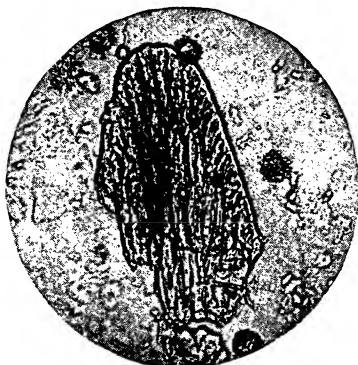


FIG. 470.—Tooth, disk floret,  $\times 140$ .



FIG. 471.—Stalked hair (magnified).



FIG. 472.—Stone cells, achene,  $\times 134$ .



FIG. 473.—Stem tissues,  $\times 84$ .

FIGS. 468-473.—Insect Powder (*Chrysanthemum cinerariaefolium*). (Bull. 824, U. S. Dept. of Agriculture.)

(*C. cinerariæfolium*) to 10-ribbed (*C. coccineum* and *C. Marschallii*) ovary or achene, a short-toothed pappus and a 5-lobed yellow corolla enveloping a style which is surrounded by synantherous stamens and which terminates in 2 style arms bearing stigmatic surfaces.

**Powdered Drug.**—Weak yellowish orange to moderate yellow; odor characteristic; sternutatory; taste acrid and bitter followed by a sensation of numb-

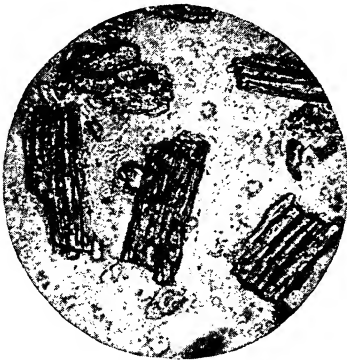


FIG. 474.—Achene tissues,  $\times 130$ .

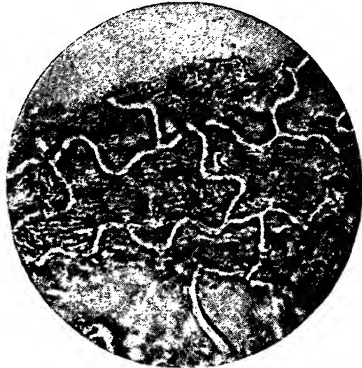


FIG. 475.—Sinuous cells, ray floret,  $\times 254$ .

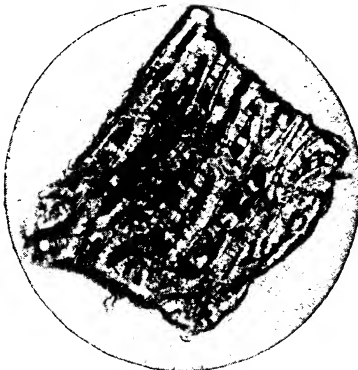


FIG. 476.—Achene tissue and crystals,  $\times 204$ .



FIG. 477.—Bract tissues,  $\times 120$ .

FIGS. 474-477.—Insect Powder (*Chrysanthemum cinerariæfolium*. (Bull. 824, U. S. Dept. of Agriculture.)

ness. Numerous T-shaped non-glandular hairs from involucre bracts with 2 basal stalk cells (usually broken) and a horizontal, tapering, pointed and usually twisted or curved end cell; fragments of the outer epidermis of the outer bracts with somewhat polygonal to slightly wavy-walled epidermal cells and many broadly elliptical stomata which are usually surrounded by 3 to 4 neighboring cells; fragments of the inner epidermis of the corolla showing numerous striated papillæ; fragments of outer epidermis of corolla with elongated, striated epidermal cells, and a few stomata that are surrounded by 4 to 5 neighboring cells; numerous fragments of the pericarp of the pistil and achene showing elongated



secretion reservoirs containing brownish, amorphous resin contents (the latter colored yellowish-green changing to brownish-black with mineral acids) and, in the Dalmatian Insect Powder only, short monoclinic prisms or diamond-shaped crystals; fragments of the seed coat with elongated, thick-walled, porous lignified stone cells and particularly abundant in powder ground from mature flower heads; spirally thickened cells from edge of pappus; fragments of pericarp of ovary and achene showing epidermis with sessile, club-shaped glandular hairs with 2- to 8-celled glandular heads; fragments of teeth of the tubular florets with rows of longitudinally elongated cells becoming smaller toward the base, most of which contain a rosette aggregate of calcium oxalate; fragments of vascular bundles; numerous spherical pollen grains from 27 to 30 $\mu$  in diameter, the exine with 3 pores and numerous conical spines of different lengths.

A relatively larger percentage of pollen and relatively smaller percentage of stone cells is found in the powder ground from the unexpanded flower heads than in that ground from mature flower heads.

**Constituents.**—Two toxic compounds called *Pyrethrin I* ( $C_{21}H_{30}O_3$ ) and *Pyrethrin II* ( $C_{22}H_{30}O_5$ ) which represent esters of the same alcohol-ketone, *pyrethrolone*, which constitute the insecticidal principles; resin, volatile oil, etc.

**Uses.**—Insecticide; parasiticide. Pyrethrum is effective against numerous kinds of chewing and sucking insects, acting both as a contact and stomach poison. A hydrocarbon oil extract of the kerosene type enters into Pyrethrum Ointment, N.N.R. which is employed in the treatment of scabies. Pyrethrum extracts also enter into insect sprays, such as fly and mosquito sprays, etc.

**Adulterants.**—(1) The flower heads of *Chrysanthemum Leucanthemum* L. known commonly as the ox-eye daisy or common field daisy; (2) Flower heads of *Helichrysum arenarium* DC. or yellow immortelle; (3) entire peduncles of Insect Flowers.

Insect powder has been frequently adulterated with powdered Pyrethrum stems, turmeric, chromate of lead, yellow ocher and ground flower heads and stems of other *Compositæ*. Less frequently used past adulterants have been ground cereals, sawdust, almond shells, white hellebore, fustic, saffron, brick dust, barium chromate, potassium chromate, aloes, arsenic, borax, jalap, nux vomica, euphorbium, quassia, pepper, soap bark, senna leaflets, sumach berries, and starches.

The flower heads of the Daisy have been one of the most common adulterants of Insect Flowers. This plant grows in practically every region where Dalmatian Insect Flowers are gathered and is common in many sections of this country. Whole Daisy flowers may be detected by the presence of relatively shorter achenes than those of Insect Flowers, each of which possesses 10 whitish ribs alternating with black stripes and with knob-like projections on its broader end. Cross sections of these achenes show *tightly arranged, elongated, narrow, palisade cells* in the outer region of each rib and *secretion reservoirs*, in the mesocarp, possessing a *dark-red amorphous substance*.

The most common recent adulterants for Insect Powder have been powdered insect flower stems or peduncles, powdered Daisy flowers and powdered turmeric.

*Insect flower stems* may be detected qualitatively, if present in considerable amounts, by the green color of the ether extract of the sample. Pure Insect flowers yield an intensely yellow ether extract, whereas that of pure stems is one of a pronounced green color. Fragments of stem tissue may be detected in the powder by mounting it in phloroglucin and hydrochloric acid and examining microscopically, when long strands of tissues with frayed out ends and composed of collenchyma cells associated with pinkish- or reddish-stained tracheæ and sclerenchyma fibers will be evident.

No chemical method has yet been devised which will determine quantitatively even an approximate amount of the stem present in an adulterated sample. This is likewise true for Insect powder which has been adulterated with powdered Daisy flowers or Turmeric. It is possible, however, to determine the approximate percentage of these three sophisticants by certain methods of microscopic analysis. See Chapter IV.

*Powdered Daisy flowers* can be definitely determined in Insect powder by the presence of dark red amorphous fragments of material from the secretion-reservoirs of the Daisy achene and by the closely arranged, narrow, thick-walled palisade cells of the outer portion of the ribs of this achene.

*Powdered turmeric* can be detected microscopically by the irregular deep yellow, altered, pasty masses of starch which become reddish-brown with KOH solution, blue with iodine T.S. and crimson with concentrated  $\text{H}_2\text{SO}_4$ . Unaltered turmeric starch grains, some with beaked ends, as well as reticulate ducts represent corroborative evidence of the presence of this adulterant, although many samples of turmeric show no unaltered starch. See Curcuma.

#### SANTONICA (SANTONICA)

**Synonyms.**—Levant Wormseed, Flores Cinæ; *Fr.* Semen Cinæ; *Ger.* Zittwer-samen, Wurmsamen.

**Botanical Origin.**—*Artemisia Cina* (Berg.) Willkomm.

**Part Used.**—The dried unexpanded flower heads.

**Ash.**—8 per cent.

**Habitat.**—Turkestan.

**Plant.**—A small shrub the aerial portion of which consists of 6 to 8 stems bearing pinnately-dissected, grayish leaves and small, oblong-ovoid, obtuse, grayish-green flower heads.

**Production and Commerce.**—The greater bulk of the present world's supply of Santonica is obtained from plants growing in the desert of Kirghiz of Turkestan. Some of the drug is grown in the Pacific Northwest. The flower heads are collected in mid-summer while unexpanded by stripping them from the stems, and rapidly dried. The commercial supplies are shipped here largely through Russia and London.

**Description.**—Oblong-ovoid, from 2 to 3.5 mm. in length and from 1 to 1.5 mm. in width, summit obtuse; consisting of an involucre of 14 to 20 glandular and imbricated bracts enclosing 3 to 5 tubular florets; apical marginal hairs absent from bracts; apices of corolla lobes devoid of trichomes and never more

than slightly papillose; externally smooth, glossy, grayish-green to brownish-green; readily crumbling to powder upon crushing; odor aromatic, somewhat camphor-like; taste aromatic and bitter.

**Constituents.**—Up to 3.5 per cent. of *santonin* (inner anhydride of *santoninic acid*); resin, volatile oil, *artemisin*, etc. *Santonin* ( $C_{15}H_{18}O_3$ ), the chief active principle, rapidly disappears with the opening of the flower head. It is present in greatest abundance in flower heads collected just before expansion and rapidly dried. *Santonin* occurs in a number of other species of *Artemisia*. It responds positively to the furfural reaction. It is colored red by alkaline alcoholic solutions.

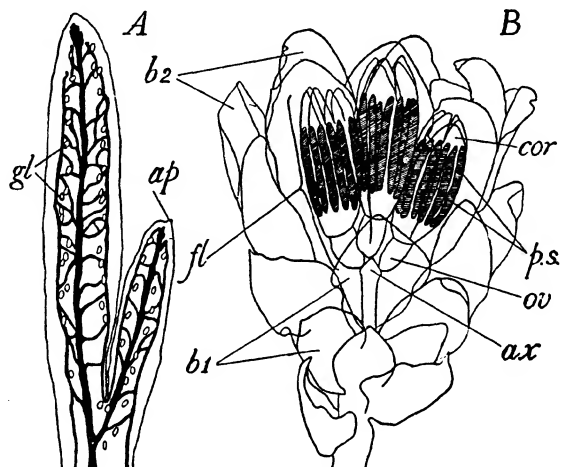


FIG. 478.—*Santonica* (*Artemisia Cina*). Leaf and flower head. A, Lobe of the foliage leaf, showing the venation: *ap*, apiculus; *gl*, gland. B, Entire flower head, cleared by boiling in chloral hydrate solution: *ax*, conical end of central axis; *b1*, outer bract; *b2*, inner bract; *cor*, corolla of tubular floret; *fl*, floret; *ov*, ovary; *p.s.*, pollen sacs. Both  $\times 15$ . (From "*Materia Medica*," Greenish, after Wallis and Mowat.)

**Uses.**—*Santonica* is used as an anthelmintic especially for round worms.

**Average Dose.**—2 Gm. (30 grains).

**Adulterants.**—(1) *Santonin-less Santonica*. This may be distinguished by the presence of apical marginal hairs upon the bracts of the flower heads, by possessing strongly lignified sclerenchyma elements, and by the presence of hairs on the leaves usually occurring in commercial samples. It is usually shipped from Persian Gulf ports. (2) *Barbary Santonica* from *Artemisia ramosa* and *Artemisia Sieberi*.

**Substitutes.**—The unexpanded flower heads of *Artemisia pauciflora* Weber and of *A. maritima* var. *Stechmanniana* Besser, both of which contain *santonin*. *Santonin* also occurs in the unexpanded flower heads of *Artemisia mexicana* Willd., *A. neo-Mexicana* Wootton and *A. Wrightii* Gray, growing in New Mexico and Mexico.

**Santonin (Santoninum)** N.F. ( $C_{15}H_{18}O_3$ ) is the inner anhydride of *santoninic acid*. It occurs in colorless rhombic crystals or as a white crystalline powder.

It is almost insoluble in water. 1 Gm. is soluble in about 45 cc. of alcohol forming a lævorotatory solution. It is used as an anthelmintic for round worms. In overdoses santonin is a delirifacient and has produced poisoning marked by giddiness, mental sluggishness, cold skin, urine tinged with yellow or green,

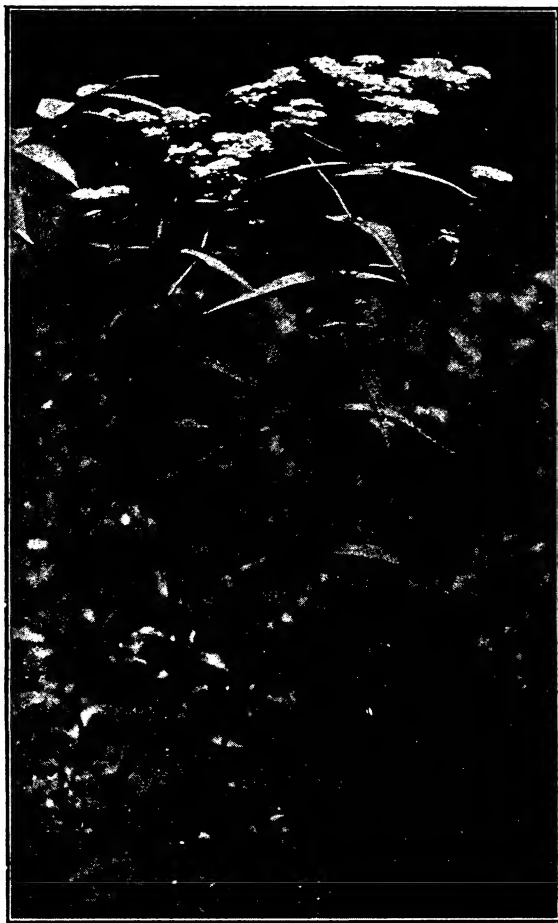


FIG. 479.—Boneset (*Eupatorium perfoliatum*). Note connate-perfoliate leaves and flower heads arranged in corymbs.

dilated pupils, profuse sweating, vomiting and finally by delirium, convulsions, unconsciousness and failure of respiration. Treatment consists of a saline purge and combatting symptoms. Av. dose, 60 mg. (1 grain). **N.F. Preparations.**—Santonin Tablets, Santonin and Calomel Tablets.

#### EUPATORIUM N.F. (EUPATORIUM)

**Synonyms.**—*Boneset*, *Thoroughwort*, Vegetable Antimony, Feverwort, Sweating Plant, Indian Sage; *Fr.* Herbe à fièvre; *Ger.* Durchwachslost.

**Botanical Origin.**—*Eupatorium perfoliatum* Linné.

**Part Used.**—The dried leaves and flowering tops.

**Purity Rubric.**—Not more than 10 per cent. of its stems and not more than 2 per cent. of other foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash.

**Habitat.**—North America.

**Plant.**—A hardy perennial herb having an erect hairy stem from 0.5 to 1.5 m. in height which bears connate-perfoliate, bright green leaves and paniced corymbs of numerous small heads of white tubular florets.

**Production and Commerce.**—Boneset is a very common weed which spreads rapidly in fields and low grounds. In this country it is found mostly east of the Mississippi. The drug is almost entirely obtained from wild plants which are cut down in late summer when in full bloom. The leaves and flowering tops are stripped from the stems by hand and carefully dried in the shade. The commercial supplies are obtained principally from central and southern United States.

**Description.**—Usually as more or less broken leaves and flowering tops; leaves connate-perfoliate, each consisting of 2 sessile lanceolate leaves, the bases of which are connate around the stem, up to 20 cm. in length and from 1.5 to 5 cm. in breadth, apex acute, margin crenate-serrate, venation rugose, upper surface rough and light olive to dark yellowish green, lower surface yellowish-gray-green, tomentose and dotted with yellow resin; flower heads small, numerous, corymbed, with a campanulate involucre of linear-lanceolate, imbricated hairy bracts and with 10 to 15 tubular, light colored florets, each with a pappus consisting of a single row of bristles; odor characteristically but slightly aromatic; taste very bitter.

**Constituents.**—A bitter glycoside called *eupatorin*; resin, volatile oil, gallic acid, a glucosidal tannin, etc.

**Use.**—Boneset is chiefly used in the form of decoction as a diaphoretic in systemic colds.

**Average Dose.**—2 Gm. (30 grains).

#### FARFARA (COLTSFOOT)

**Synonyms.**—Coltsfoot Leaves, Tussilago Leaves, Horse-, Bull's-, Fool's-, or Ass's-foot Leaves, British Tobacco, Herba Farfaræ, *Ger.* Huflattigblätter; *Fr.* Feuilles de tussilage.

**Botanical Origin.**—*Tussilago Farfara* Linné.

**Part Used.**—The dried leaf.

**Purity Rubric.**—Not more than 3 per cent. of foreign organic matter and not more than 4 per cent. of acid-insoluble ash (N.F. V).

**Habitat.**—Europe.

**Plant.**—A low perennial woolly herb whose underground portion consists of a horizontal rhizome and root system. Its aerial portion consists of a rosette of heart shaped to ovate-reniform, toothed, radical leaves and a scape bearing a single, terminal, yellow, flower head which is surrounded by reddish involucre bracts. The flowering scapes appear before the leaves in the spring.

**Production and Commerce.**—Coltsfoot grows in wet places and somewhat sandy soil in central and southern Europe and in the northeastern and north central part of the United States and lower Canada. The leaves are generally gathered in June and July and carefully dried. The commercial supply of the drug is obtained from Europe, largely through Trieste and Leghorn.

**Description.**—Leaves usually broken and folded together; when entire, petiole long and pubescent; lamina broadly ovate-reniform, nearly orbicular or cordate, from 8 to 18 cm. in length and up to 18 cm. in breadth, rounded or acute at the apex, deeply cordate at the base, angularly lobed and dentate with red-brown teeth along the margin, palmately 5- to 9-nerved; upper surface dull

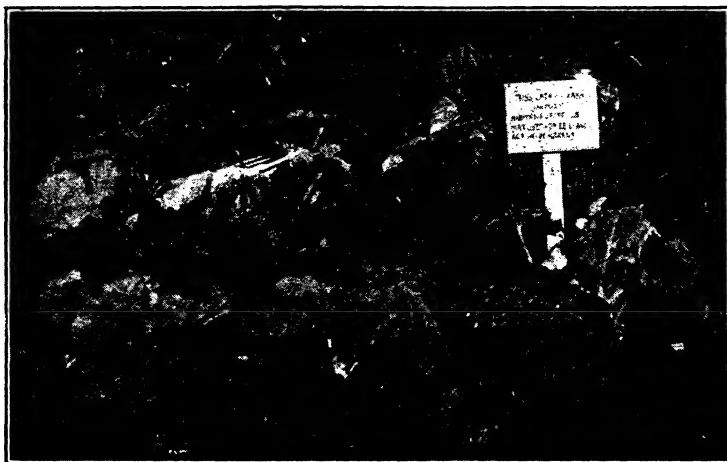


FIG. 480.—*Tussilago Farfara* (coltsfoot). (Photograph by Hogstad.)

grayish-green, nearly glabrous; lower surface white-tomentose; odor indistinct, taste mucilaginous and bitter.

**Constituents.**—*Mucilage*, gallic, tartaric and malic acids, cholin, phytosterin, traces of volatile oil and resin; tannin, etc.

**Use.**—Coltsfoot is used by the laity in the treatment of coughs.

**Average Dose.**—4 Gm. (60 grains).

**Adulterants.**—Leaves of *Petasites* and *Arctium* spp.

#### SENECIO (SENECIO)

**Synonyms.**—Life Root, Golden Senecio, Ragwort.

**Botanical Origin.**—*Senecio aureus* Linné.

**Part Used.**—The dried plant.

**Habitat.**—In swampy grounds and moist thickets of eastern and central United States, south to Virginia and Arkansas.

**Plant.**—A perennial herb whose underground portion consists of a slender branching rhizome system from which arise erect stems bearing alternate lyrate to pinnatifid leaves, the uppermost ones being sessile and bractiform. The

basal radical leaves are rounded ovate to oblong, deeply cordate at base, and form a rosette. The inflorescences consist of loose corymbs of bright yellow heads.



FIG. 481.—*Senecio aureus* L. or Life Root. Two plants collected by the author at Charlton, Mass.  $\times \frac{1}{2}$ .

**Production and Commerce.**—The aerial portions of this plant are gathered from June to August, when the plant is in flower, and carefully dried. The commercial supplies of the drug come from central United States.

**Description.**—Usually in the form of a mixture of broken stems, leaves and flower heads; when entire, stems from 3 to 6 dm. in length, when young, white

tomentose, when mature glabrous, and showing, if entire from base upward, a rosette of long petioled, rounded-ovate, obtuse, cordate, crenate-dentate, radical leaves and cauline leaves of transitional forms which pass from lyrate to sessile pinnatifid to amplexicaul, oblong and cleft and correspondingly smaller until quite bract-like in uppermost region; flower heads in terminal loose corymbs, each up to 25 mm. in breadth and showing a flat naked receptacle surrounded by usually 2 series of lance-linear appressed bracts and bearing usually 10 bright yellow ligulate florets and numerous yellow, perfect, tubular florets, each with a white bristly pappus; odor aromatic; taste bitter, acrid and pungent.

**Constituents.**—The alkaloid *aureine*, volatile oil, bitter principle, etc.

**Uses.**—Life Root is used as an emmenagogue.

**Average Dose.**—4 Gm. (60 grains).

#### TARAXACUM N.F. (TARAXACUM)

**Synonyms.**—*Dandelion Root*, Common Dandelion, Lion's Tooth, Puff- or Blow Ball; *Ger.* Löwenzahn, Pfaffenröhrchen; *Fr.* Dent de Lion, Couronne de moine.

**Botanical Origin.**—*Taraxacum officinale* Weber ex Wiggers and *Taraxacum laevigatum* DC.

**Part Used.**—The dried rhizome and roots.

**Purity Rubric.**—Not more than 2 per cent. of foreign organic matter; it yields not more than 4 per cent. of acid-insoluble ash.

**Habitat.**—Europe. Naturalized in North America.

**Plants.**—*Taraxacum officinale* is a perennial herb naturalized in North America where it is common in grassy places, fields, meadows and along roadsides. It consists of an underground, long, straight, tapering, fleshy brown root which is continued upward as a simple or branched rhizome. From this arises a rosette of bright-green runcinate leaves and later, from the center of the rosette, a hollow scape bearing on its summit a broad orange-yellow head of ligulate flowers. The fruit is a fusiform, greenish-brown achene, terminated by a slender stalk which is crowned by a silky, spreading pappus, the entire fruiting head of achenes, globular.

*Taraxacum laevigatum*, the Smooth- or Red-Seeded Dandelion (*T. erythrospermum* Andrz.), differs from the common dandelion in possessing smaller runcinate leaves which are more deeply cut, smaller, sulfur-yellow flower heads, and red to reddish-brown achenes which are shorter beaked.

**Production and Commerce.**—Dandelion thrives in any good soil. The fruits are sown in the spring, being placed in rows from 1½ to 2 feet apart and covered by about ½ in. of soil. The seedlings are later thinned to stand about a foot apart in each row. Cultivation is necessary to keep down weeds. The roots of wild plants are dug in the early spring before the vegetative processes begin or in the fall immediately after they cease. The roots of plants under cultivation are best dug in the fall of the second season after planting. They are then washed, the thicker roots sliced and all carefully dried and stored in



closed containers in which a few drops of carbon tetrachloride are placed from time to time to prevent attacks by insects.

Most of the drug used in this country is collected from wild plants and has been imported from Russia, Italy, Belgium, Yugoslavia and Netherlands in burlap bags. It is also being produced from plants cultivated in this country.



FIG. 482.—*Taraxacum*. Note the roots with multiple crowns. In the lower half of the figure, the characteristic depressed stem scars are evident,  $\times \frac{1}{4}$ .

**Description.**—Cylindrical or somewhat flattened, gradually tapering, up to 15 cm. in length and from 5 to 15 mm. in diameter, usually in broken segments; externally blackish-brown, dark-brown or moderate yellowish brown, longitudinally wrinkled with few root or rootlet scars; crown simple or branched with numerous leaf-bases exhibiting annulate markings; fracture short and horny; internally bark light brown, containing concentrically arranged lighter and darker zones which represent parenchyma alternating with laticiferous vessels and sieve; wood light yellow and porous; odor slight; taste bitter.

**Histology.**—Transverse sections of macerated Dandelion root show the following peculiarities

1. *External Cork* of up to 4 layers of tangentially-elongated cork cells with brownish contents.
2. *Cork cambium*.

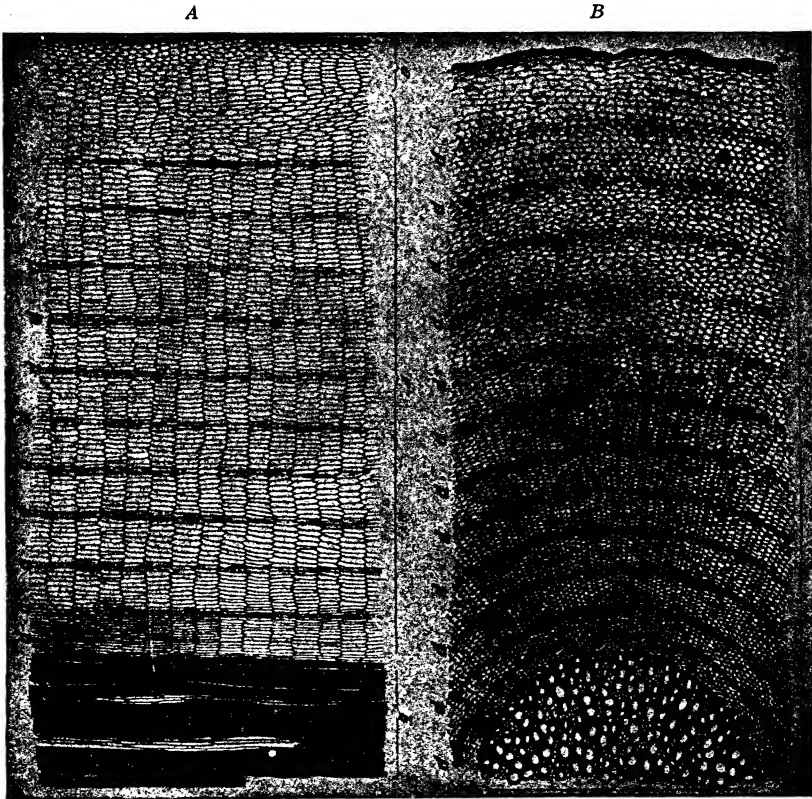


FIG. 483.—*Taraxacum* Root. *B*, Representative portion of transverse section and *A*, of longitudinal-radial section showing *h*, cork; *o*, cortex; *v*, phloem; *b*, xylem and *p*, laticiferous vessels,  $\times 40$ . (After Berg.)

3. *Cortex* of several layers of more or less tangentially-elongated cells containing inulin. *Internal cork* is frequently found arising from secondary phellogens at various levels in this region.

4. *Phloem*, a broad zone of brownish concentric layers of laticiferous vessels and sieve tubes alternating with whitish parenchyma, the cells of which contain inulin.

5. *Cambium*, comprising several layers of small meristematic cells.

6. *Xylem*, filling the center of the root and composed of a matrix of non-lignified wood fibers and xylem cells among which are scattered numerous tracheæ, the latter up to about  $84\mu$  in diameter.

The **rhizomes** mainly differ from the roots by showing a small pith in the center.

Tangential sections, cut through the phloem and mounted in weak iodine, show a network of branching laticiferous vessels with brownish contents which anastomose with one another. Accompanying these latex carrying elements

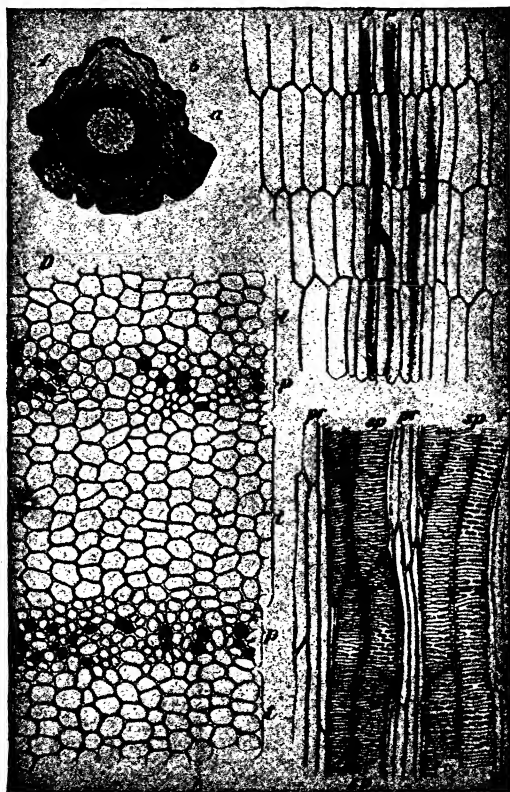


FIG. 484.—*Taraxacum*. *A*, Cross section of dried root ( $\times 4$ ) showing concentrically arranged lines of laticiferous vessels in cortex and phloem. *D*, Transverse section of a portion of the phloem showing two zones of laticiferous vessels,  $\times 160$ . *E*, Radial-longitudinal section of a portion of the phloem showing a zone of laticiferous vessels,  $\times 160$ . *F*, A portion of a radial-longitudinal section of the wood,  $\times 160$ . *a*, bark; *b*, wood; *w*, cambium; *p*, laticiferous vessels; *t*, phloem parenchyma; *pr*, wood fibers; *sp*, reticulate tracheae. (After Berg.)

are sieve tubes. These and their callus plates may readily be made out by mounting a similar section in corallin soda solution, when the callus sieve plates take on a pink coloration.

Radial-longitudinal sections show that the tracheae of the xylem are for the most part reticulate. The wood fibers accompanying them have simple and oblique pores.

**Powdered Drug.**—Pale brown to weak yellowish orange; numerous parenchyma cells containing irregular masses of inulin; fragments with brown to yellow anastomosing laticiferous vessels; fragments of reticulated tracheae up to

84 $\mu$  in width associated with non-lignified wood fibers having oblique and simple pores; no starch.

**Constituents.**—*Taraxacin* (bitter principle); taraxacerin, inulin, a sugar called l  vulin, choline, resin, fat acids, 2 phytosterols (taraxasterol and homotaraxasterol), etc. Inulin is most abundant in autumn, sugar in spring.

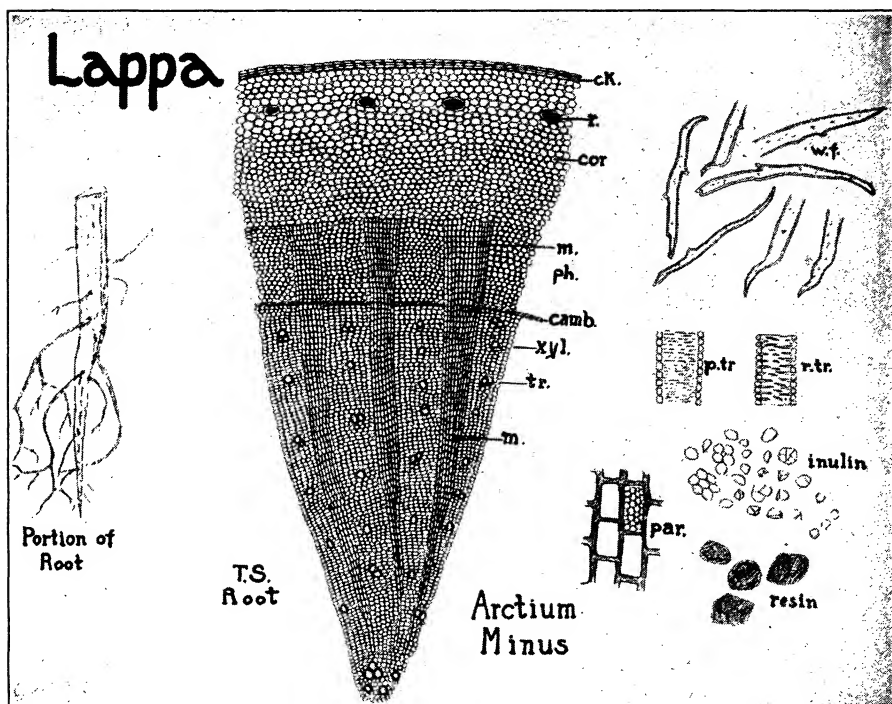


FIG. 485.—First-year root of *Arctium minus*. The chief source of American Burdock Root. *ck*, cork; *r*, resin cells; *cor*, cortex; *ph*, phloem; *m*, medullary ray; *camb*, cambium; *xyl*, xylem; *tr*, trachea. On right, elements of powdered root: *wf*, wood fibers from crown; *p.tr.*, portion of pitted trachea; *r.tr.*, portion of reticulate trachea; *par.*, parenchyma. [From Youngken and Vander Wyk in *Jour. A. Ph. A.*, 28 (1939), 19.]

**Uses.**—*Taraxacum* is chiefly used as a simple bitter, and as a mild laxative in catarrhal jaundice.

**Average Dose.**—4 Gm. (1 drachm).

**Preparations.**—*Taraxacum* Fluidextract, 4 cc. (1 fl. dr.); Glycerinated Gentian Elixir (from Fld. ext.); Compound *Taraxacum* Elixir (from Fld. ext.).

**Adulterants.**—(1) Chicory, the rhizome and roots of *Cichorium Intybus* (*Composit  *), which is often gathered by mistake along with Dandelion, since it frequently occurs in the same localities in which the latter abounds. Like Dandelion, it also contains laticiferous vessels but these are arranged with the sieve tubes in radiate fashion, as observed in transverse sections, the radiating phloem patches being separated by broad medullary-rays. (2) The roots of species of *Lactuca* (Lettuce) which show radial rows of trache  , usually one

cell wide, in the xylem patches, the latter separated from each other by medullary-rays 2 to 3 cells in width.

#### LAPPA (LAPPA)

**Synonyms.**—*Burdock Root*, Beggar's Buttons, Hareburr; *Ger.* Klettenwurz, *Radix Bardanæ*; *Fr.* Bardane.

**Botanical Origin.**—*Arctium Lappa* Linné and *Arctium minus* Bernhardt.

**Part Used.**—The dried first year root.

**Purity Rubric.**—Not more than 4 per cent. of attached leaf bases and not more than 2 per cent. of other foreign organic matter; it yields not more than 3 per cent. of acid-insoluble ash, not more than 10 per cent. of crude fiber and not less than 8 per cent. of alcohol-soluble extractive. N.F. VII.

**Habitat.**—Europe and Asia.

**Plants.**—*Arctium Lappa* or Great Burdock is a coarse biennial herb naturalized in this country from Europe, and found as a common weed along roadsides and in waste places. The first year's aerial growth consists of a rosette of rough, cordate-oblong leaves with solid, deeply furrowed petioles. During the second year a stem arises to the height of 4 to 9 ft., becoming much branched and bearing alternate, petiolate, smaller ovate to cordate to cordate-oblong, irregularly toothed leaves and solitary or clustered capitula of purple tubular flowers. Each head is 3 to 5 cm. broad and its receptacle is surrounded by a glabrous involucre of imbricated, lanceolate to linear-attenuate bracts with hooked tips. The spines of the inner bracts equal or exceed the flowers. The fruits consist of oblong, flattened and angular achenes.

*Arctium minus* or Common Burdock somewhat resembles the former species, but is smaller, up to 5 ft. in height, possesses hollow petioles which are not deeply furrowed and its flower heads are only up to 3 cm. in breadth and possess shorter and more linear bracts, the spines of the inner bracts being erect and shorter than the flowers.

**Production and Commerce.**—The root is collected from wild and cultivated first year plants in autumn, washed (the thicker roots longitudinally sliced to facilitate drying), and carefully dried. The plants are readily propagated from fruits sown in the fall or spring directly in the field.

The commercial article has been mostly imported in bags from Belgium, Germany, France and Italy. The drug is also gathered from wild and cultivated plants growing in this country.

**Description.**—Fusiform, of variable length, from 4 to 18 mm. in diameter near the crown; frequently split longitudinally or in broken segments; externally moderate brown to weak yellowish-orange, longitudinally wrinkled, the crown annulate and frequently showing a woolly tuft of leaf remnants; fracture short and horny; a dark cambium separating the thick bark from the porous and radiate wood; odor indistinct; taste mucilaginous, sweetish, then bitter.

**Histology.**—Transverse sections of first-year roots show the following structural characteristics: (See Fig. 485, p. 895.)

1. *Cork*, of 1 to 3 layers of thin-walled, brownish, brick-shaped cork cells.

2. *Cork cambium.*

3. *Cortex*, a broad zone of about 30 layers of parenchyma containing for the most part glistening masses of irregularly angled inulin crystals when sections are mounted in alcohol. The outer region contains large, thick-walled cells containing a yellow resin.

4. *Phloem*, a narrow zone of slender patches of sieve tubes and inulin containing phloem parenchyma, separated by broad phloem rays.

5. *Cambium* composed of small, more or less collapsed, meristematic cells.

6. *Xylem*, filling up the center and composed of narrow, radiate xylem strands, separated by broad wood rays up to 13 cells in width. Each xylem strand is composed of inulin-containing wood parenchyma and a few pitted and reticulate tracheæ, mostly occurring singly, and only occasional wood fibers with thin walls can be observed accompanying the tracheæ. These occur in the upper crown region of the first-year root. (In old second year roots wood fibers are abundant throughout the entire commercial root.) The cells of the medullary-rays contain inulin.

**Powdered Drug.**—Weak yellowish-orange to weak yellow; numerous thin-walled cells of the cortex, wood parenchyma and medullary-rays containing glistening masses of irregularly angled inulin crystals, the latter up to  $10\mu$  in diameter; fragments of cortical parenchyma containing yellowish-orange to greenish-yellow resin cells; fragments of tracheæ with elliptical pits and reticulate tracheæ, occasional spiral tracheæ from attached leaf bases; fragments of brownish cork tissue; only occasional non-lignified, wavy, wood fibers with thin walls and broad lumen from the crown region.

**Constituents.**—*Bitter principle*, mucilage, inulin (40 to 50 per cent.), *fixed and volatile oils*, *resin*, tannin, mineral substances, stigmasterin and sitosterin, sugar, etc. The first year root yielded 8.61 per cent. of alcohol-soluble extractive, the second year root 2.71 per cent. Total ash, 5 to 6 per cent.

**Uses.**—Burdock is used as a diaphoretic, diuretic and alterative, chiefly in domestic medicine. "Burdock root oil" is a perfumed and colored preparation of Burdock with a fixed oil, such as castor oil, and alcohol.

**Average Dose.**—2 Gm. (30 grains).

**Preparation.**—Fluidextract, 2 cc. (30 minims).

## INULA (INULA)

**Synonyms.**—Elecampane; *Fr.* Racine d'aunée; *Ger.* Alantwurz.

**Botanical Origin.**—*Inula Helenium* Linné.

**Part Used.**—The dried rhizome and roots.

**Habitat.**—Europe and Asia, along roadsides and in damp pasture land.

**Plant.**—A perennial herb growing to the height of 1.8 m., with a thick, solid, striated, hairy, branched stem bearing large, half clasping, alternate, cordate-oblong, unequally dentate-serrate leaves (lower radical leaves, petioled and elliptic-oblong) that are woolly beneath, and large, golden-yellow, radiate heads of flowers. Each flower head is about 6 cm. wide and consists of a naked receptacle bearing yellow, pistillate, ligulate flowers along the margin and a

disk of yellow, perfect, tubular flowers in the center, its exterior being covered by an imbricated involucre, the outer bracts of which are leaf-like. The fruit is a 4- to 5-ribbed achene.



FIG. 486.—*Inula Helenium* Linné. Upper portion of stem bearing leaves and flower heads in stages of maturation.  $\times \frac{1}{2}$ .

**Production and Commerce.**—Elecampane is naturalized in the United States, extending from Nova Scotia as far south as North Carolina and westward to Missouri. It has been cultivated to a small extent on drug farms for its rhizome and roots. It thrives best on a clay loam which has been deeply

ploughed and kept moist. The plants are grown from seeds or from cuttings of old roots. If from the former, the seeds should be sown in seed beds early in the spring and the seedlings later transferred to the field, where they should be set 18 inches apart in rows with at least 3 feet between each row for cultivation. Root cuttings are planted in autumn in the same manner as the seedlings.

The rhizomes and roots should be dug up in August of the second year, washed, cut into longitudinal, transverse or oblique slices and dried in the shade. They should be preserved in air-tight containers to which carbon tetrachloride or chloroform is added from time to time to prevent insect attacks.

Most of the drug is imported in bales or bags from Trieste and Rotterdam.

**Description.**—Rhizome fleshy and fusiform, when entire, branching; usually cut into longitudinal or oblique or occasionally transverse pieces, to which may be attached one or more roots; of variable length and up to 4 cm. in diameter; externally grayish-brown to dark-brown, longitudinally wrinkled, with occasional buds or stem scars; inner or cut surface somewhat concave, the edges incurved with the overlapping bark, yellowish-brown to grayish-brown, longitudinally striate and more or less fibrous near the cambium zone; fracture short and horny; inner surface light brown and showing circular or elliptical markings; roots cylindrical and tapering, frequently twisted, up to 15 cm. in length and 1.6 cm. in diameter; odor characteristically aromatic; taste aromatic, then acrid and pungent.

**Histology.**—Transverse sections of rhizomes exhibit the following characteristics passing from periphery toward the center:

1. *Cork*, of several rows of thin-walled, brownish, tabular cells.
2. *Cork cambium*, of meristematic cells.
3. *Cortex*, a zone of many layers of parenchyma cells containing inulin masses.
4. *Pericycle*, of several layers of parenchyma cells. In old rhizomes this region contains many discontinuous groups of sclerenchyma fibers.
5. *Phloem*, consisting of radially arranged phloem patches separated by broad medullary-rays. Circular oleoresin reservoirs are arranged in nearly radial rows and form interrupted circles in this region and the cortex.
6. *Cambium*, of meristematic cells.
7. *Xylem*, in young rhizomes, consisting of radiate wedges separated by broad medullary-rays which contain oleoresin reservoirs. Each xylem patch consists of a matrix of inulin-containing wood parenchyma, imbedded in which are a number of pitted and reticulate tracheæ associated occasionally with a few strongly lignified wood fibers. Xylem in old rhizomes shows narrow medullary rays and thick-walled, lignified wood fibers replacing wood parenchyma.
8. *Pith*, consisting of large-celled parenchyma containing inulin in smaller amounts than in the cortex. Intercellular-air-spaces in this zone are large.

**Powdered Drug.**—Light brown; consisting chiefly of fragments of parenchyma containing inulin and small, irregular, separated masses of inulin; fragments of highly colored oleoresin; occasional reddish-brown fragments of the walls of the oleoresin reservoirs; fragments of tracheæ with reticulate thickening or elliptical pores associated occasionally with wood fibers.



**Constituents.**—1 to 2 per cent of an active crystalline substance known as *alant-camphor* or *helenin* which is a mixture of *alantolactone* ( $C_{15}H_{20}O_2$ ), iso-alantolactone and dihydroalantolactone; inulin, acrid resin, volatile oil with a peppermint-like odor and consisting chiefly of alantol, inulinin, mucilage, etc.

**Uses.**—Elecampane is used as an ingredient in veterinary pulmonic powders and numerous proprietary medicines. Its active constituent, helenin, has been employed as an antiseptic and bactericide in pulmonary diseases. Alantolactone is an anthelmintic.

**Average Dose.**—2 Gm. (30 grains). Dose of alantolactone, 10 to 200 mg.

#### ECHINACEA N.F. (ECHINACEA)

**Synonyms.**—Cone Flower, Purple Cone Flower.

**Botanical Origin.**—*Echinacea pallida* (Nuttall) Britton and *Echinacea angustifolia* (DC.) Heller.

**Part Used.**—The dried rhizome and roots.

**Purity Rubric.**—Not more than 3 per cent. of foreign organic matter; it yields not more than 2 per cent. of acid-insoluble ash. It must not be dispensed after it has lost its characteristic odor and taste.

**Habitat.**—Central United States.

**Plant.**—*Echinacea pallida* is a perennial herb with stout stem arising to the height of 3 ft. or less, bearing alternate, lanceolate to linear-lanceolate, often serrate and long petioled, 3- to 5-nerved leaves below, naked above, and terminating in a single, large, rose purple, conical head of ligulate and tubular flowers. The ligulate flowers are slender and drooping with the 2-toothed limb. The fruit is a short 4-sided akene with a short-toothed pappus.

*Echinacea angustifolia* is a lower perennial herb than the preceding, 1 to 2 ft. in height; its leaves are lanceolate, oblong-lanceolate to linear-lanceolate, tapering at base, entire and usually 3-nerved; its ligulate flowers are purplish to white with a 2-3-toothed limb.

**Production and Commerce.**—*Echinacea* grows wild in the central states from Michigan and Kansas to Texas and Alabama and occurs sparingly in some of the eastern states. Plants propagated from seeds have been found to do well in moderately rich and well drained loam but the rhizomes do not attain a size suitable for marketing until three or four years from the time of sowing the seed. Whenever cultivated, the plants should be left in the seed bed for two years before transplanting to the field. They should be set about  $1\frac{1}{2}$  feet apart in rows with sufficient space intervening between these for cultivation.

The rhizomes and roots are dug up in autumn, cleaned, and dried either by artificial heat or in the sun. The commercial supply of the drug comes from Kansas.

**Description.**—Nearly entire and broken pieces of the rhizomes and roots, from 10 to 20 cm. long and from 4 to 15 mm. in diameter. Rhizome vertical, usually twisted and crooked, slightly tapering, the summit showing a simple or multiple crown with one or more stem bases or V-shaped scars; rhizome and roots externally varying from pale brown or moderate yellowish-brown to

purplish-brown, longitudinally wrinkled, the rhizome slightly annulate in upper portion with occasional stem-scars or bases of aerial stems; fracture short or somewhat fibrous; internally exhibiting a very narrow bark and a broad wood zone composed of alternating wedge-shaped yellowish and blackish areas, the rhizome possessing a small central pith area; odor slightly aromatic; taste sweet and followed by a tingling sensation.

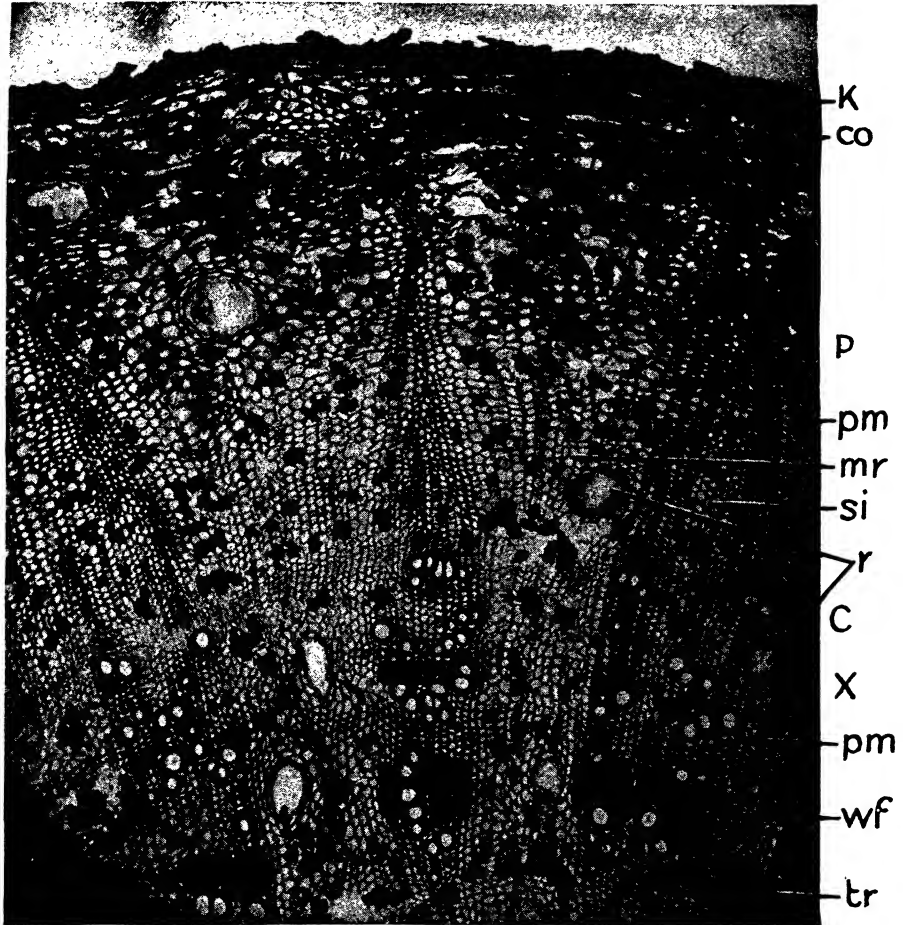


FIG. 487.—Echinacea. Cross section of rhizome,  $\times 50$ . *K*, cork; *co*, cortex; *p*, phloem; *C*, cambium; *x*, xylem; *pm*, phytomelane; *mr*, medullary ray; *r*, secretion reservoirs; *wf*, wood fibers; *tr*, tracheae.

**Histology.**—Sections of the rhizome exhibit the following structural peculiarities:

1. *Cork*, composed of several rows of tabular cells with suberized walls and containing oil globules or granular masses.
2. *Hypodermis*, of several layers of tangentially-elongated cells amongst which occur oleoresin reservoirs of schizogenous formation.

3. *Cortex*, of numerous layers of more or less polygonal to spheroidal inulin-containing parenchyma, scattered amongst which are good sized secretion reservoirs with amber colored oleoresin and many somewhat elongated stone cells. In the intercellular spaces adjacent to the stone cells there is found a black, carbon-like substance termed *phytomelane*.

4. *Pericycle*, in which are imbedded strongly lignified, lamellated sclerenchyma fibers, arranged singly and in groups.



FIG. 488.—Tansy (*Tanacetum vulgare*). (Photograph by Hogstad.)

5. *Fibrovascular bundles* of the open collateral type, each consisting of a narrow cone-shaped phloem composed of soft bast, a prominent cambium and an elongated, wedge-shaped, radiate xylem composed of radially arranged, often interrupted, rows of pitted, spiral, reticulate and occasional bordered pored tracheæ imbedded in inulin-containing wood parenchyma. Broad medullary rays intervene between the bundles. These are composed for the most part of a matrix of inulin-containing parenchyma in which are scattered schizogenous oleoresin reservoirs and thick-walled, lamellated, distinctly porous stone cells similar to those found in the cortex. In the intercellular-air-spaces adjacent to these occurs a black deposit of phytomelane.

6. *Pith*, composed of tissue similar to the cortex.

The root shows a somewhat similar histology but is devoid of pith.

**Powdered Drug.**—Pale brown to pale olive; numerous stone cells or fibers up to  $300\mu$  in length and up to  $42\mu$  in diameter, strongly lignified and carrying carbon-like deposits of phytomelane; numerous fragments of tracheæ up to  $75\mu$  in diameter and with simple pores, annular or reticulate markings, occasionally with bordered pores or double spiral markings; oleoresin reservoirs from 80 to  $145\mu$  in diameter, the latter containing a yellow to yellowish-orange oleoresin, which deteriorates in old roots to a reddish-brown resin; fragments of lignified sclerenchyma fibers; fragments of parenchyma containing inulin; a few brownish fragments of cork.

**Constituents.**—Resins, inulin, saccharose, *volatile oil*, *phytomelane*, etc.

**Uses.**—Echinacea is employed in the treatment of ulcers, boils and septicæmia.

**Average Dose.**—1 Gm. (15 grains).

**Preparation.**—Fluidextract, 1 cc.

#### TANSY (TANACETUM)

**Synonyms.**—Herba Tanaceti, Double Tansy, Common Tansy.

**Botanical Origin.**—*Tanacetum vulgare* Linné.

**Part Used.**—The dried leaves and flowering tops.

**Habitat.**—Europe. Naturalized and cultivated in the U. S. A. and Europe.

**Plant.**—A strongly aromatic perennial herb up to 1 m. in height, with pinnately-divided leaves, and terminal corymbs of yellow, discoidal flower heads.

**Description.**—Leaves pinnately-divided or deeply pinnatifid, the segments oblong or lanceolate, serrate or incised, smooth, dark green and more or less glandular; flower heads in corymbs each head of numerous yellow tubular florets arranged upon a convex, naked receptacle, the latter surrounded by imbricated bracts; stems very slightly hairy and angled; odor strongly aromatic; taste bitter, aromatic and slightly acrid.

**Constituents.**—Up to 0.3 per cent. of *volatile oil* containing 70 per cent. of a ketone called tanacetone (which is probably identical with thujone), borneol and a terpene; a bitter substance called *tanacetin*, resin, etc.

**Uses.**—Tansy is used in domestic medicine chiefly in the form of a tea as an emmenagogue, anthelmintic and aromatic bitter.

**Average Dose.**—2 Gm. (30 grains).

#### LACTUCARIUM (LACTUCARIUM)

**Synonyms.**—Wild Lettuce, Acrid Lettuce, Prickly Lettuce; *Fr.* Laitue vireuse; *Ger.* Giftlattichsaft.

**Botanical Origin.**—*Lactuca virosa* Linné.

**Part Used.**—The dried milk juice.

**Habitat.**—Europe and Western Asia.

**Plant.**—A biennial, latex-containing herb bearing a basal rosette of large, runcinate, radical leaves from the center of which arises an erect, prickly, pale green, often purple blotched stem, bearing alternate pale green, sessile, runcinate

leaves which possess spines along the midrib of the lower surface. The inflorescence consists of panicles of pale yellow flower heads.

**Production and Commerce.**—The plant grows wild in various sections of central and southern Europe and in New England. It has been cultivated for the milk juice in England, Scotland, France, Austria and Germany. The drug is collected mainly near Zell, Germany, from May to September by collectors

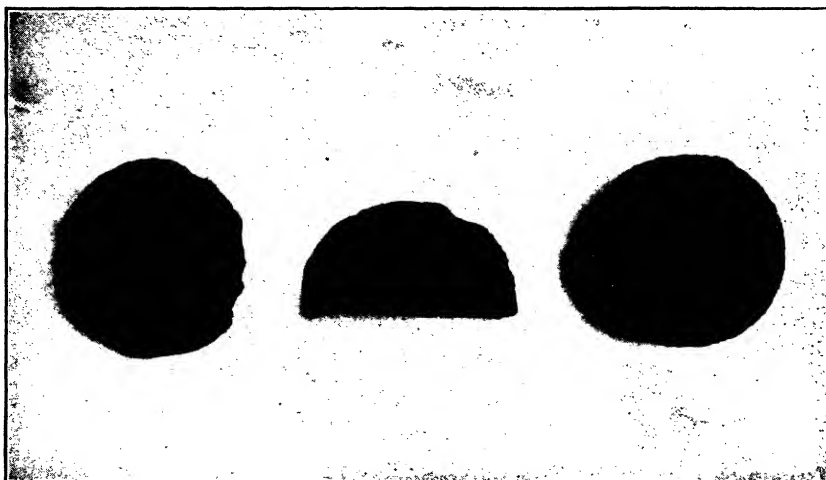


FIG. 489.—Lactucarium,  $\times 5\%$ . (Photograph by Stoneback.)

who cut off the tops of stems when a milk juice exudes. This is removed by the finger and transferred to china receptacles. Fresh slices of the stem are removed daily and an additional amount of juice collected until the plants are exhausted. When sufficiently hardened in the receptacles, it is removed by gently heating the exterior of the cup and tapping, often cut into 2 or 4 pieces and allowed to become hard and dry. The commercial supplies are obtained chiefly from Germany.

**Description.**—In hemispherical cakes, or in halved or quartered hemispherical cakes, or rarely in irregular masses; externally dull reddish- or grayish-brown; fracture tough, waxy; internally light-brown, porous; odor somewhat opium-like; taste bitter.

**Constituents.**—The bitter principles, *lactucin*, *lactucopicrin* and *lactucic acid*, *volatile oil*, lactucerin, caoutchouc, citric acid, malic acid, oxalic acid, etc. Dymond detected the alkaloid, hyoscyamine, in the plant but it has not been proven to exist in the drug.

**Use.**—Lactucarium has been employed as a mild sedative in coughs.

**Average Dose.**—1 Gm. (15 grains).

#### ACHILLEA

**Synonyms.**—Yarrow, Milfoil, Thousand-leaf, Old-man's Pepper.

**Botanical Origin.**—*Achillea Millefolium* Linné.

**Part Used.**—The dried herb collected when in flower.

**Habitat.**—North America, Europe and Asia.

**Plant.**—A perennial herb up to 2 ft. in height with a furrowed, grayish hairy stem, branched toward the summit, bearing alternate, twice to thrice pinnatifid,



FIG. 490.—*Achillea Millefolium* L., the Yarrow or Milfoil.  $\times \frac{1}{2}$ .

lanceolate leaves with linear end lobes and terminating in dense, nearly flat-topped, compound corymbs of small white flower heads. Each flower head possesses a flat, chaffy receptacle surrounded by an ovoid-cylindric involucre

of imbricated and keeled, oblong, obtuse bracts. Inserted into the receptacle are 4 to 6 white or rarely pink- or purple-tinged pistillate ray florets and numerous yellow, perfect disk florets. The odor is characteristically aromatic; the taste, bitter, aromatic and astringent.

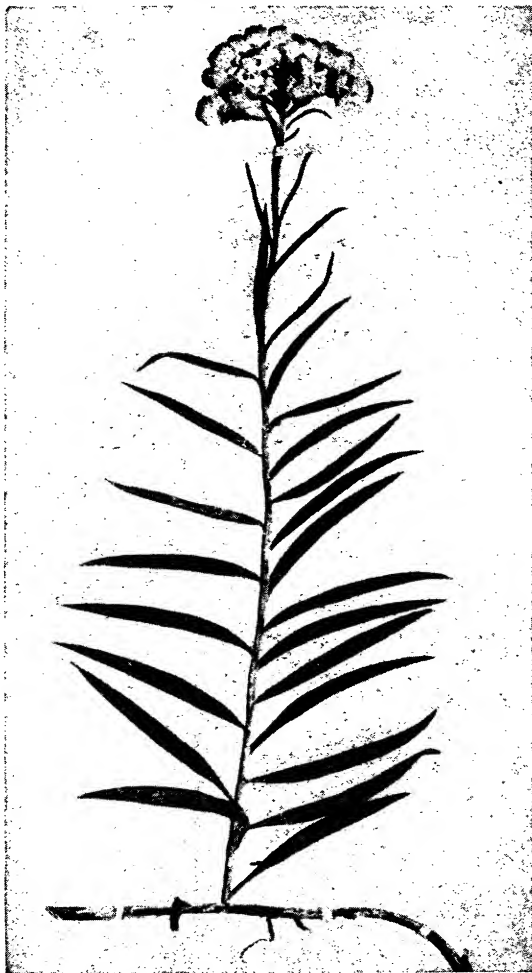


FIG. 491.—*Gnaphalium obtusifolium* L.  $\times 3\frac{1}{2}$ .

**Constituents.**—An azure-blue aromatic *volatile oil*, a brownish-red substance called achillein, achilleic acid, a dark yellow, resinous, bitter substance called *ivain*, tannin, etc.

**Uses.**—Aromatic bitter, diaphoretic and emmenagogue.

**Average Dose.**—4 Gm. (1 drachm).

#### GNAPHALIUM (LIFE EVERLASTING)

The dried flowering herb of *Gnaphalium obtusifolium* L. (*G. polycephalum* Michx.) commonly known as Sweet or Fragrant Life Everlasting, Sweet Balsam

and Rabbit Tobacco and of *Anaphalis margaritacea* (L.) Benth. & Hook. known as the Pearly or Large-flowered Everlasting and Cotton Weed, woolly herbs, indigenous to North America.

**Description.**—Stems white-woolly, corymbosely-branched at summit and leafy; leaves linear-lanceolate to lanceolate, sessile, woolly beneath, green above, revolute or undulate (*Gnaphalium obtusifolium*); heads numerous, each with white or pearly white involucre of ovate-oblong to ovate-lanceolate, obtuse bracts which are white, but sometimes tinged with brown, and tubular flowers



FIG. 492.—*Cnicus benedictus* (Blessed Thistle).

having a bristly pappus; odor characteristically aromatic; taste bitter and aromatic.

**Constituents.**—*Volatile oil*, bitter principle, tannin, etc.

**Uses.**—In the form of an infusion, in domestic medicine, for pulmonary and intestinal catarrh and for diarrhoea and locally as a fomentation for bruises.

**Average Dose.**—4 Gm. (60 grains).

#### CNICUS (CNICUS)

**Synonyms.**—Blessed Thistle, Herba Cardui Benedicti; *Ger.* Benedikten Distel; *Fr.* Chardon Bénit.

**Botanical Origin.**—*Cnicus benedictus* Linné.



**Part Used.**—The dried overground portion.

**Habitat.**—Europe. Naturalized in North America from Nova Scotia to Georgia.

**Plant.**—An annual, spreading, caulescent herb with alternate, lanceolate, usually sinuate-pinnatifid, spinescent leaves, sessile and clasping above, and



FIG. 493.—*Carthamus tinctorius*, source of American Saffron.

large, leafy-bracted, many flowered heads of yellow, tubular flowers. The latter are borne upon a common receptacle bearing numerous capillary bristles which is surrounded by an ovoid involucre of coriaceous, appressed bracts, the larger of which terminate in long branched spines. The fruit is a stout, terete, achene with numerous prominent ribs and crowned with a pappus composed of 10 short, horny teeth and bearing 10 elongated bristles in an outer row and 10 shorter bristles in an inner row.

The dried herb possesses a slight unpleasant odor and a bitter taste. It should yield not more than 20 per cent. of total ash.

**Production and Commerce.**—Most of the drug used in this country has been imported from Europe, but within recent years increasing amounts have

been produced from plants cultivated in Georgia and Tennessee. The seed should be sown early in the spring in ordinary garden soil at a depth of  $\frac{1}{4}$  to  $\frac{1}{2}$  in., in rows about 3 ft. apart, the plants about 20 in. apart in the row. Cultivation is necessary to keep down weeds until the plants begin to develop flower stalks. The crop should be harvested by cutting off the herb at ground level when the plants have begun to blossom. It should be dried similarly to tobacco in well ventilated sheds and kept in a clean, dry place until baled for the market. Moldiness, occurring in drug which has not been properly dried, is the main cause of inferiority.

**Constituents.**—A crystalline bitter principle called *cnicin*, volatile oil, resin, mucilage, etc.

**Uses.**—As a bitter tonic in the form of a decoction or extract.

**Dose.**—2 to 4 Gm.

#### CARTHAMUS (CARTHAMUS)

**Synonyms.**—Safflower, American-, African-, or Dyer's Saffron, Flores Carthami; *Ger.* Saflor; *Fr.* Fleurs de carthame.

**Botanical Origin.**—*Carthamus tinctorius* Willd.

**Part Used.**—The dried florets.

**Habitat.**—India, Egypt and the Levant.

**Plant.**—An annual herb, 1 to 2 ft. in height with ovate, spiny-toothed leaves and leafy-bracted heads of orangetubular flowers.

**Description.**—Entire or broken orange-red to brownish-red tubular florets, up to about 40 mm. in length; when entire, consisting of an oblong ovary with a tubular corolla, the tube narrow, about 25 mm. in length and ending in a limb of 5 long, linear lobes; projecting from the throat of the corolla are 5, yellow, syngenesious anthers forming a tube through which extends the style terminating in a bi-fid stigma; odor slightly aromatic; taste slightly bitter.

**Constituents.**—A red coloring substance called *carthamin* or *carthamic acid* (0.3 to 0.6 per cent.), a yellow coloring substance called *safflower-yellow*, soluble in water (24 to 30 per cent.), mucilage, fixed oil, etc.

**Uses.**—Diaphoretic in hot infusion to promote eruption in measles and other exanthematous diseases; laxative; as a dyestuff.

**Dose.**—0.5 to 1 Gm.

## CHAPTER II

### DRUGS OF ANIMAL ORIGIN

#### PHYLUM PROTOZOA

A large group of unicellular animals of world-wide distribution, occurring in fresh and salt water, and in soil. Some species occur in loose colonies, as *Carchesium*, etc. The Protozoa are subdivided into four classes, namely, the Sarcodina or Rhizopoda, the Mastigophora, the Sporozoa and the Infusoria. Reproduction is by cell division, conjugation, and spore formation.

#### CLASS SARCODINA

This group of Protozoa comprises forms possessing pseudopodia. It includes the order Lobosa, represented by the *Amoeba* and the *Endamoeba*, species of the latter genus being responsible for amoebic dysentery and pyorrhea, and the Orders Radiolaria, Heliozoa and Foraminifera.

The **Foraminifera** are mostly marine protozoa which possess fine, branching pseudopodia and whose bodies are covered by calcareous or chitinous shells perforated by a foramen through which the pseudopodia protrude. The shells of many species of this order, especially of the genera *Globigerina* and *Nummulites* are composed largely of calcium carbonate. Through the ages they have been deposited on the floors of ancient seas where, along with spicules of fossil sponges and the exoskeleta of mollusks, they have solidified to form natural chalk deposits. Such deposits are particularly abundant on both sides of the English Channel, forming huge white cliffs of chalk, notable for their height especially at Dover, England and Dieppe, France. Fossil deposits of chalk have also been found in Iowa, the Dakotas, Arkansas, Texas and other states.

#### PREPARED CHALK U.S.P. (CRETA PRÆPARATA)

**Synonyms.**—*Drop Chalk*, Creta Lævigata; *Fr.* Craie Lavée; *Ger.* Präparirte Kreide.

**Definition.**—A native form of calcium carbonate freed from most of its impurities by elutriation, and containing, when dried to constant weight at 200°C., not less than 97 per cent. of  $\text{CaCO}_3$ .

**Description.**—It occurs as a white or grayish-white, microcrystalline powder often formed into conical-shaped masses; odorless and tasteless; insoluble in water and alcohol, but dissolving in diluted  $\text{HCl}$  and in diluted  $\text{HNO}_3$  with effervescence.

**Uses.**—Internally as an antacid in diarrhea accompanied with acidity, and in gastric acidity, as an antidote for poisoning by oxalic acid; externally in skin lotions for forms of dermatitis and as a protective absorbent dusting powder.

**Average Dose.**—1 Gm. (15 grains).

**Preparations.**—Compound Chalk Powder, N.F., 2 Gm. (30 gr.); Aromatic Chalk Powder, N.F., 2 Gm. (30 grains); Chalk Mixture, U.S.P., 15 cc. (4 fl. dr.); Hydrargyrum cum Creta, N.F. (Gray Powder), 0.25 Gm. (4 gr.).

## THE METAZOA (MULTICELLULAR ANIMALS)

### PHYLUM PORIFERA (SPONGES)

The sponges are diploblastic (two-layered), radially-symmetrical animals with a plant-like habit. Their bodies vary greatly in shape and in complexity of organization. The body wall consists of an outer or dermal epithelium and an inner or gastral epithelium, the two layers being separated by a jelly-like substance containing amoeboid wandering cells called the mesogloea. The simplest sponges like *Grantia* possess a single hollow central cavity known as the gastral cavity which opens to the exterior by a single large exhalant opening, the osculum, but higher forms like the bath sponges possess numerous gastral cavities and oscula. The external surface of sponges is dotted with numerous minute inhalant pores which lead into canals and these into flagellated chambers lined by choanocytes, the flagellated chambers leading into canals which open by pores on the wall of the gastral cavity. Sponges are devoid of a coelum or body cavity. Reproduction is sexual and by budding. The more complicated sponges like the bath sponges possess such power of budding and lateral growth that they become dense masses of sponge made up of many zooids or individuals in organic connection with each other. Most sponges are marine, relatively few species occurring in fresh water.

### COMMERCIAL SPONGES

The sponges of commerce grow in relatively shallow water attached to rocks in the oceans. They are propagated by cuttings from live sponges made under water which are fastened upon the sandy bottom by skewers. These cuttings reach maturity within several years. Sponges are gathered by divers, by dredging and by means of long handled forks or tridents. Their soft bodies are brought to the surface and placed aboard boats which convey them to the sandy shore where they are allowed to decay, sometimes by burial in the sand for a period. They are then washed and beaten, threaded on cord and dried. Some are bleached by chemicals.

Bath sponges have a skeleton of spongin, a horny substance, which is stiff and hard when dry, but flexible when moistened. They belong to the genera *Euspongia* and *Hippospongia*. They are obtained from the Mediterranean sea chiefly along the coasts of Italy, Crete, Cyprus, the Grecian Archipelago and Asia Minor, and from the Atlantic Ocean, along the coast of Florida and the Bahama Islands.

The Mediterranean sponges are representatives of 3 distinct species, viz.:

- (1) *Euspongia officinalis* which yields the finest grade of soft bath sponges,
- (2) *Euspongia zimocca*, the source of the hard or Zimocca sponge and (3) *Hippospongia equina* which yields the common or horse sponge.

The Florida and Bahama sponges are members of the following species, viz.: (1) *Hippospongia gossypina* or Sheep's Wool Sponge, (2) *Euspongia agaricina*, or Yellow Sponge, (3) *Hippospongia graminea* and *H. cerebriformis* or Grass Sponges, (4) *Hippospongia meandrinaeformis*, the Velvet Sponge, and (5) *Euspongia tubulifera*, the Glove Sponge.

**Uses.**—Sponges are used for cleaning and washing, and for absorbing liquids. Sponge tents are used for dilating sinuses.

#### PHYLUM ANNELIDA

The annelids are triploblastic, segmented worms whose bodies are divided into a linear series of somites. They possess a coelom or cavity in the mesoderm which communicates with the exterior by paired nephridia. Their nervous system consists of a dorsal pair of cerebral ganglia, a commissural ring around the gullet and a ventral, ganglionated nerve cord. The phylum includes the earthworms, sandworms and leeches.

#### CLASS HIRUDINEA

The members of this class of annelids are known as leeches. They are parasitic, hermaphrodite worms characterized by being usually flattened dorso-ventrally, by possessing 33 internal segments, a variable number of external rings (2 to 14) to each true segment, and an anterior and posterior sucker.

#### LEECH (HIRUDO)

**Synonyms.**—Green Leech; *Ger.* Blutegel; *Fr.* Sangsue.

**Zoological Origin.**—*Hirudo medicinalis* Linné.

**Habitat.**—In marshes and running streams of Europe.

**Description.**—The European medicinal leech is characterized by its olive-green, dorsoventrally-flattened body, 2 to 4 in. in length, marked on its dorsal surface with 6 longitudinal reddish stripes, its ventral surface being yellowish-green with black spots or longitudinal stripes in varieties. In the center of the anterior sucker is the mouth containing 3 lenticular jaws each armed with 2 rows of teeth.

**Use.**—For local depletion; to remove small quantities of blood from tender or sensitive regions.

**Preservation.**—Leeches should be kept in jars of soft water such as river water, in a shaded place, free from noxious vapors and at a temperature of 50 to 68°F. The bottom of the vessel should be covered with pebbles, moss and some coarse charcoal, and the water should be changed at least twice weekly.

Leeches may be made to disgorge blood by placing them in a solution of table salt. To remove a leech from a wound before its body is fully gorged with blood, sprinkle it with salt.

#### PHYLUM MOLLUSCA

The mollusks comprise a very large phylum of invertebrates which are unsegmented and without appendages. Most of them possess a ventral pro-

trusion serving for locomotion and called the foot. A projecting dorsal fold of the body-wall forms a mantle which secretes a shell covering the viscera, but these may be absent. Respiration is usually by gills or ctenidia. The group includes clams, oysters, mussels, snails, scallops, devil fishes (octopus), squids and cuttlefishes.

### CLASS CEPHALOPODA

#### CUTTLEFISH BONE (OS SEPIA)

Cuttlefish Bone or Cuttle-bone is a calcareous body found in the muscular mantle of *Sepia officinalis* L. (Order *Dibranchia*; Class *Cephalopoda*).

**Animal.**—The cuttle fish is a shield-shaped mollusk up to about a foot in length and about 5 in. in width whose body is fringed by a fin. Its head bears 8 short and 2 long, fleshy sucker-bearing arms, a pair of large eyes and a mouth with parrot-beak-like jaws. It is native to the Mediterranean Sea.

**Description.**—It occurs as a white, ovate-oblong bone about 10 to 12 cm. in length with sharp edges, of a hard texture externally, porous and brittle internally; inodorous; taste saline.

**Constituents.**—Chiefly calcium carbonate (80 to 85 per cent.), sodium chloride, calcium phosphate, magnesia, etc.

**Uses.**—Antacid; extensively employed in the manufacture of tooth powders; in polishing powders; in bird cages.

### PHYLUM ARTHROPODA

The largest group of invertebrates, many of which are of great economic importance. It contains about 500,000 species grouped into the following classes:

Class 1. Crustacea. Examples: *Daphnia*, a test animal; crayfishes, crabs, lobsters, barnacles and shrimps.

Class 2. Onychophora. Examples: *Peripatus*, an important connecting link between arthropods and annelids.

Class 3. Myriapoda. Examples: Centipedes and millipedes.

Class 4. Insecta. Examples: Cochineal, *Cantharis*, bees, ants, locusts.

Class 5. Arachnida. Examples: Spiders, scorpions, mites.

All of these animals have bodies consisting of a series of somites some or all of which bear jointed appendages, an exoskeleton consisting of chitin and in some instances of added calcareous deposits, an alimentary tube with mouth and anus, a dorsal blood vessel, a brain situated dorsally in the head, and a ventral nerve cord.

### CLASS INSECTA

The largest group of living animals, belonging to the Invertebrata Division of the Animal Kingdom. Their bodies are divisible into three distinct regions, viz., head, thorax and abdomen. Antennæ, eyes (simple and compound), and mouth parts consisting of maxillæ, mandibles, labium and hypopharynx (tongue) are found in the head. Wings either one or two pair on thorax together with three pairs of legs. Ten segments typical in abdomen. Respiration is by

a system of branching tracheæ which extend from openings called spiracles on the exterior of the body. Examples. Grasshoppers, Dragon-flies, Bees, Moths, Beetles, Flies, etc.

#### ORDER HEMIPTERA

Insects having suctorial mouth parts, and direct metamorphosis (with the exception of the male members of the *Coccidæ*). Wings present and segments of the antennæ few.

#### SUBORDER HOMOPTERA

Characterized by four, sloping, membranous and similar wings. The head is very closely united to the thorax and the distal ends of the front legs touch the sides of the head.

#### FAMILY COCCIDÆ

This family comprises the scale insects and mealy bugs, which are injurious to cultivated plants.

The species differ greatly from other families of this order and also inter se. The males, unlike other Hemiptera, undergo a complete metamorphosis and possess only one pair of wings. The female has no mouth, is always devoid of wings, and, after fertilization, develops viviparous larvæ. In addition, it is covered by means of scales, either in powder or in plates, which form a protective case or roof. Some members of this family yield shellac, wax, dye-stuffs, etc.

#### COCHINEAL U.S.P. (COCCUS)

**Synonyms.**—Cochineal Insect; Red Scale Insect; *Fr.* Cochenille; *Ger.* Coccionella.

**Zoological Origin.**—*Coccus cacti* Linné.

**Part Used.**—The dried female insects enclosing the young larvæ.

**Habitat.**—On species of the Cactus family found in Mexico, Central America, and Peru.

**Production and Commerce.**—The wingless female insects live on the stems of various members of the *Cactaceæ*, but are chiefly found on *Nopalea coccinellifera*, an abundant plant of the subtropics. They are placed on the branches by the natives and multiply very rapidly. The males alone have wings and, shortly after they copulate with the females, die. The fecundated females increase considerably in size and retain the larvæ in their bodies until they die. The larvæ mature in about 2 weeks and escape from the dead body of the mother insect. The life cycle consumes about 6 weeks. Up to 5 generations of these insects are produced yearly by breeders. The female insects are collected by brushing them from the branches with brooms. They are then killed by plunging them into boiling water or by the fumes of burning sulfur or charcoal or by oven heat. They may be dried on trays for several hours in the sun or artificially in an oven at about 65°C., when the commercial variety known as "Silver Grain Cochineal" is obtained. The silvery color of the insects of this variety is due to the fact that their wax coating is not melted. If dried at a tempera-

ture higher than the melting point of their wax covering, *i.e.*, a temperature of more than  $106^{\circ}\text{C}$ ., the commercial variety known as "Black Grain Cochineal" results. The "Granilla" variety consists of small, immature females and is

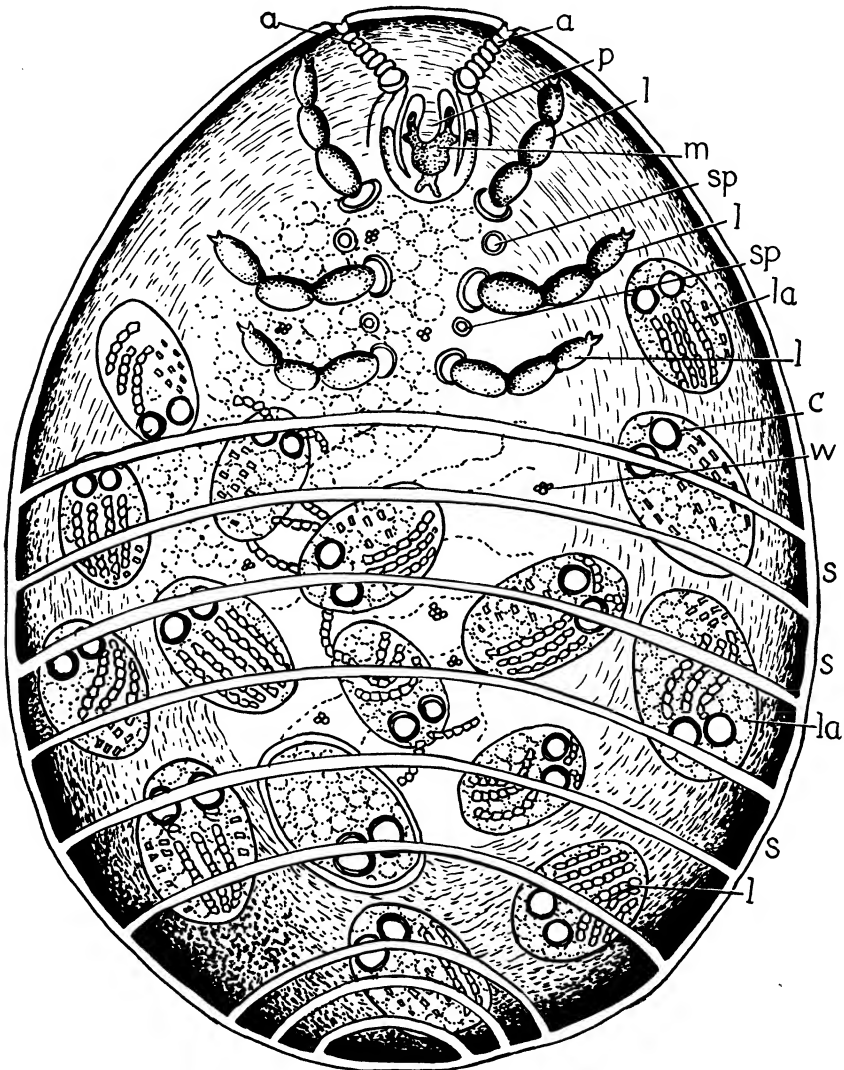


FIG. 494.—Cochineal insect (*Coccus cacti*). Magnified. Decolorized mature female, ventral view, showing body wall enclosing numerous larvæ (*la*). *a*, antennæ; *p*, proboscis; *m*, mouth parts; *sp*, spiracles or breathing pores; *l*, legs; *c*, coiled beak of larva; *s*, abdominal somites; *w*, pores of wax-glands.

deficient in coloring matter. Madres cochineal represents the first brood of the year and generally demands the highest price.

The insects have been introduced from Mexico and Central America to the Canary Islands, Algeria, Spain and the East and West Indies.



The commercial supplies used in this country come chiefly from Peru and Teneriffe, an island of the Canary group.

**Description.**—Insect, ovate in outline, convex on dorsal surface and showing from 9 to 12 segments, concave on ventral surface, from 3.5 to 6 mm. in length; externally grayish, grayish-purple, grayish-black, or purplish-black to very dusky red purple; the ventral surface showing 2 straight, 7-jointed antennæ located in the anterior end, 3 pairs of short legs each terminating in a single claw, and a highly modified mouth showing a long, filiform proboscis composed of 4 very fine chitinous styles, in 2 pairs, the anterior pair representing the mandibles and the posterior pair representing the first maxillæ; 4 spiracles are visible, an anterior pair between the middle and hind legs; entire surface more or less chitinous and showing numerous solitary or clustered, tubular or spinneret wax glands; the insect, after decolorization, exhibiting numerous larvæ, all of which are covered by the shell-like chitinous abdomen of the mother insect; the larvæ characterized by their proboscides appearing as 2 circular coils, rows of tubular wax glands, and in the more developed stages, 3 pairs of legs, antennæ and other characteristics of the mature insect; odor characteristic; when tasted, slightly bitter and imparting a red color to the saliva.

**Powdered Drug.**—Very dusky to very dark red; numerous fragments of muscle fibers; fragments of the chitinous exoskeleton with wax glands; fragments of larvæ with coiled proboscides; occasional claws and leg segments; fragments of antennæ and chitinous styles.

**Identity Test.**—The red color of Cochineal solutions is changed to reddish purple by alkalis and to weak orange by acids.

**Adulterants.**—The "Silver Grain" variety has been admixed with carbonate or sulphate of barium or lead as well as talcum. The "Black Grain" variety has been admixed with manganese dioxide, graphite and ivory black. These minerals may be detected by macerating in water and noting separation of an insoluble powder.

**Constituents.**—*Carminic acid* (a purple, water-soluble coloring principle), fixed oil, wax, myristin, etc.

**Use.**—Coloring agent; source of carmine.

**Preparations.**—Compound Cardamom Tincture, U.S.P. 4 cc. (1 fl. dr.); Cochineal Solution (*Cochineal Color*), N.F.

**Carmine (Carminum)** N.F. is the aluminum lake of the coloring principle obtained from cochineal. It occurs in irregular, angular, bright red, odorless fragments or as a powder. It is only slightly soluble in water, producing a red color but freely soluble in alkaline liquids imparting to these a dark purplish-red solution. Coloring agent.

**Preparation.**—Carmine Solution, N.F.

#### LAC (LACCA)

**Synonyms.**—Shellac, Resina Lacca; *Ger. Lack*; *Fr. Laque*.

**Definition.**—A resinous secretion that encrusts the bodies of *Tachardia lacca* Kerr (*Lakshadia indica* Madhihassan) or other species of *Tachardia*.

**Habitat.**—India, Burma and Assam.

**Animals.**—Small scale insects of orange red color, about 0.5 mm. in length occurring in dense colonies forming a crust on the twigs and branches of various trees which they puncture with their proboscis and suck the juices.

**Production and Commerce.**—The lac insect occurs chiefly on trees of *Ficus religiosa* and *Ficus indica* (Fam. *Moraceæ*), *Schleichera trijuga* (Fam. *Sapindaceæ*), *Aleurites laccifera* (Fam. *Euphorbiaceæ*), *Acacia arabica* and *Butea frondosa* (Fam. *Leguminosæ*) which are cultivated in various parts of India as host plants for the propagation of the insect. Two or three broods of the insects are reared each year. To insure large production, the natives break off twigs covered with female insects and tie them on to uninfested trees.

The young branches and twigs which are covered by a crust composed of the bodies of the insects are broken off after the resin has been secreted and constitute *stick lac*. The crust is usually scraped from the branches for export and occurs in channeled pieces of deep reddish-brown color which, when chewed, color the saliva red.

The *stick lac* is partially deprived of its coloring matter by maceration in water or dilute soda solution and the colored solution strained and evaporated to dryness, forming a product called "lac dye." The resinous matter which remains on the straining cloths is spread on floors to dry and constitutes "*seed lac*."

*Shellac* is prepared from either the scrapings of stick lac or from lac, previously deprived of any water-soluble coloring matter, by melting it with a small amount of added orpiment and resin, straining it through cloths and pouring it upon smooth flat plates. The strained material is stretched while hot into thin sheets. These are broken up into flaky fragments and constitute "*flake shellac*." Flake shellac occurs in different colors, the principal varieties being *orange shellac* which has a brownish-yellow color and *garnet shellac* which is reddish-brown. Most of the lac is produced in western Bengal and other provinces of India and is exported to this country through Calcutta or indirectly through Great Britain. Bleached shellac is usually imported from Germany and Belgium.

**Description.**—Flake shellac occurs in thin, brownish-yellow, brown, or reddish-brown, translucent fragments, insoluble in water but soluble in alcohol and in solutions of the alkalies: odorless and tasteless.

**Constituents.**—Shellac contains about 90 per cent. of resin; also wax, and a coloring substance called laccaic acid.

**Uses.**—In varnishes, as the principal ingredient in sealing wax, in polishes, electrical apparatus, etc.

#### ORDER COLEOPTERA

Wings four, the front pair of which form the horny elytra which form a line at the middle of the back. The prothorax is large and the mouth has well-

developed mandibles. Metamorphosis is indirect. Examples: Firefly, Tiger Beetle, Potato Beetle, Click Beetles, Blistering Beetles, etc.

#### FAMILY MELOIDEÆ

Five tarsal joints are present on each of the front and middle legs, but the last pair has only four with a pair of claws. Integument rather soft.

#### CANTHARIS N.F. (CANTHARIDES)

**Synonyms.**—*Spanish Flies*, *Russian Flies*, *Pulvis Cantharidis* P.I., Blister Beetle; *Fr.* Cantharides; *Ger.* Spanische Fliegen.

**Zoological Origin.**—*Cantharis vesicatoria* (Linné) De Geer.

**Part Used.**—The dried insects.

**Purity Rubric.**—Not less than 0.6 per cent. of cantharidin and not more than 10 per cent. of moisture.

**Habitat.**—Europe and western Asia.



FIG. 495.—C, Spanish Flies (*Cantharis vesicatoria*); M, Chinese Blistering Beetles (*Mylabris*). In center to left, elytra of *Cantharis*, to right, elytra of *Mylabris*.  $\times \frac{3}{4}$ .

**Production and Commerce.**—The insects are found in southern and central Europe and western Asia on various shrubs and trees of the Olive and Honey-suckle families. They appear to be most frequent in Spain, southern Russia, Roumania, Galicia, Italy, Sicily, southern France and Hungary. They are collected mainly during the months of June and July by masked collectors who, during the early morning hours, while the beetles show little sign of activity, spread cloths beneath the shrubbery and trees harboring them and then beat the branches with poles. The beetles are shaken off and, gathered up in the cloth, are cast into suitable containers and killed by the vapors of ether, chloroform, ammonia or carbon disulphide. They are then carefully dried at a temperature not above 40°C. Cantharides with an ammoniacal odor should not be used. Not more than 10 per cent. of moisture should be present in the

drug. The commercial supplies imported into the United States come from Spain and Russia in cases. The Russian article is sometimes shipped here through London and Hamburg.

**Description.**—Beetle oblong, from 15 to 25 mm. in length and up to 8 mm. in breadth; of a brilliant green, or bluish-green to bluish-purple, metallic luster,

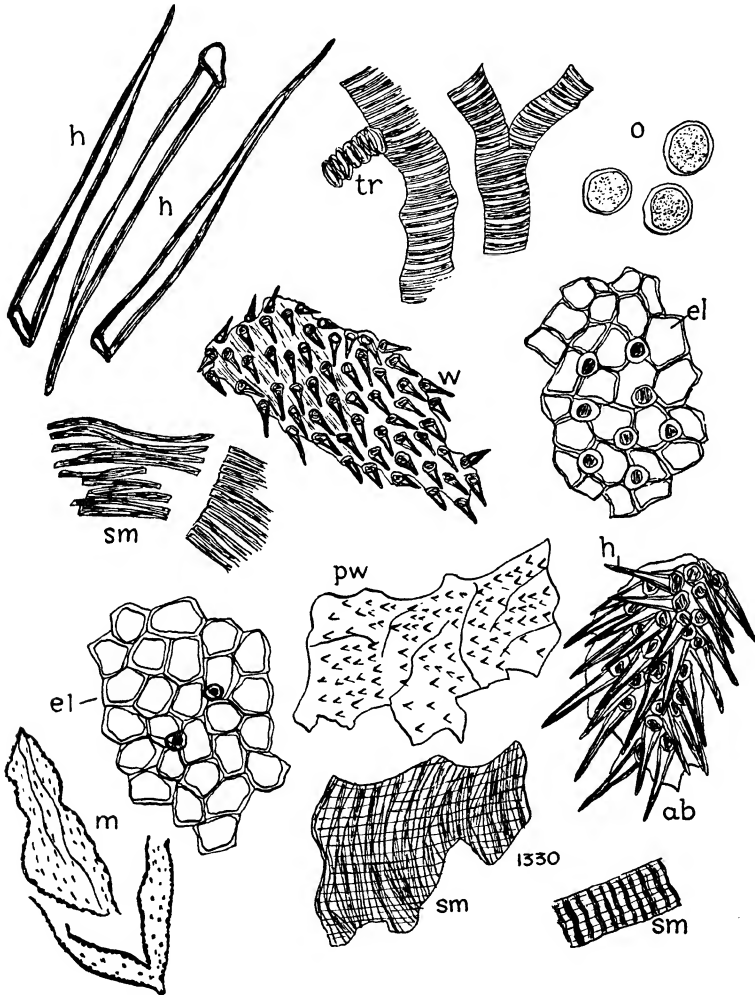


FIG. 496.—Powdered Cantharides. *h*, long pointed hairs (spicules); *tr*, tracheæ (respiratory tubules); *o*, eggs; *sm*, striated muscle; *el*, fragments of elytra; *w* and *pw*, fragments of membranous posterior wings; *ab*, fragment of chitinous exoskeleton of abdomen; *m*, fragments of mite.

changing in different regions, particularly beneath, to a golden green; head triangular, separated into two symmetrical lateral lobes by a faint median line; mouth parts mandibulate; mandibles stout; antennæ filiform of 11 conical joints, the basal clavate, the second globular and the rest somewhat conical, the

distal ones being black; neck recognizable; prothorax angulate; first and second pairs of legs with 5 tarsal joints, the third pair of legs with 4 tarsal joints, all legs with 2 distal claws; anterior pair of wings or elytra elongated, each with 2 parallel lines and finely wrinkled, covering over the folded posterior pair of wings which are yellowish-brown or yellowish-orange and membranous; odor strong and characteristic; taste pungent and acrid.

**Powdered Drug.**—Moderate yellowish-brown to moderate olive-brown with shining green or iridescent particles, showing in microscopical mounts fragments of striated muscles, long pointed unicellular hairs (spicules) about  $500\mu$  in length and  $20\mu$  in width at the base, fragments of chitinous body wall, wings and frequently fragments of mites and moths, and their eggs.

**Constituents.**—From 0.5 to 1 per cent. *cantharidin* (vesicant principle), uric, formic and acetic acids, fixed oil, etc.

Cantharidin may be micro-sublimed from powdered cantharides in prismatic rods.

**Uses.**—Cantharides is chiefly used as a vesicant and counterirritant. Internally it has an aphrodisiac and a diuretic action.

**Average Dose** (unof.).—0.06 Gm. (1 grain).

**Preparations.**—Cantharides Cerate, N.F., Cantharides Tincture, N.F., 0.1 cc. ( $1\frac{1}{2}$  minims).

**Substitutes.**—1. *Mylabris cichorii* Fabr. and *M. sida* Fabr. or Chinese Blistering Beetles from China, Malaya and India. *Mylabris cichorii* differs from Cantharis in having jet black bodies, 10 to 15 mm. in length, the elytra of which possess yellow hairs and show 2 broad brownish-yellow or orange-yellow bands and, in their anterior part, 2 spots of the same color. 2. *Mylabris sida* beetles somewhat resemble those of *M. cichorii* but are larger, up to 25 or 30 mm. in length and about 9 mm. broad with long black elytra marked by 2 broad, wavy, transverse orange-colored bands and a large orange area at the base of each. They contain up to 1.2 per cent. of cantharidin. The supplies of *Mylabris* to this country come in cases from Shanghai and Singapore.

#### ORDER HYMENOPTERA

Insects whose mouth parts are adapted for both chewing and sucking. The wings are four in number, alike, membranous with few irregular veins. The prothorax is small and united with other thorax segments. The ovipositor is modified to serve some special purpose such as sawing or boring. The metamorphosis is complete. Examples: Bees, Gall-flies, Wasps and Ants.

#### FAMILY APIDÆ

A large family of hymenopterous insects characterized by possessing short stout mouth parts and posterior tibiæ devoid of apical spurs. Examples: Honey Bee, Leaf Cutter and Carpenter Bee.

#### HONEY N.F. (MEL)

**Synonyms.**—Mel Depuratum; *Clarified Honey*; *Strained Honey*; Fr. Miel; Ger. Honig.

**Zoological Origin.**—*Apis mellifera* Linné.

**Part Used.**—A saccharine substance deposited in the honey-comb by the bee.

**Purity Rubric.**—It must be free from foreign substances such as parts of insects, leaves, etc., but may contain pollen grains.

**Habitat.**—North America and Europe.

**Animal.**—This is the common honeybee much prized for its honey and wax. The species shows differentiation into three types of individuals, viz.: the queen bee which is a sexually perfect female, the drones or males, and the worker which in reality is a sexually imperfect female. In respect to size, the queen is much larger than either drone or worker. Her sole duty is to lay eggs and thus reproduce the colony. The worker bees collect the honey, feed the young, and form the hive. All but the drones have a poison sac with a sharp sting attached. In nature, the honeybee is now found wild and lives in swarms consisting of thousands of individuals.

**Production.**—It is collected by draining the honey-comb, found in bee hives.

**Description.**—A thick, light yellowish or yellowish-brown syrupy liquid, translucent when fresh, but gradually becoming opaque and granular from crystallization of dextrose, crystalline; odor characteristic; taste sweet and faintly acrid. When diluted with twice its weight of water, it is only slightly turbid, not stringy and has a specific gravity of not less than 1.099. It is laevorotatory at 20°C.

When examined under the microscope it frequently shows the presence of the various types of pollen grains corresponding to those different plants which the bees have visited in gathering the honey.

**Constituents.**—*Dextrose* (which crystallizes), *laevulose* (which remains liquid), *volatile oil*, mucilage, proteids, coloring matter, a little wax and formic acid.

**Use.**—Honey is used as a nutritive, demulcent, mild laxative and as a vehicle for medicaments employed as gargles.

**Preparation.**—*Mel Rosæ et Sodii Boratis*, N.F. VII.

**Adulterants.**—(1) Syrup; (2) added invert sugar; (3) azo dyes and other foreign coloring substances.

#### WHITE WAX U.S.P. (CERA ALBA)

**Synonyms.**—*Bleached Beeswax*, White Bee's Wax; *Ger.* Weisses Wachs; *Fr.* Cire blanche.

**Zoological Origin.**—*Apis mellifera* Linné.

**Part Used.**—Bleached yellow wax.

**Description.**—A yellowish-white solid, somewhat translucent in thin layers, occurring in circular cakes, melting between 62° and 65°C.; odor faint and characteristic; nearly tasteless.

**Production.**—White wax is obtained by exposing thin sheets of yellow wax to moisture and sunlight.

**Constituents.**—Similar to yellow wax but containing little or no coloring matter.

**Uses.**—White wax is used pharmaceutically in the preparation of penicillin injection in oil and wax, simple cerate, camphor ointment, cold cream, and other ointments.

## YELLOW WAX U.S.P. (CERA FLAVA)

**Synonyms.**—*Beeswax*, Yellow Bee's Wax; *Ger.* Gelbes Wachs; *Fr.* Cire jaune.

**Zoological Origin.**—*Apis mellifera* Linné.

**Part Used.**—The purified honeycomb of the bee.

**Description.**—A yellow to brownish-yellow or grayish-brown solid occurring as variously molded cakes, brittle when cold and when broken exhibiting a dull granular, non-crystalline fracture; specific gravity 0.950 to 0.960 at 25°C.; melting point between 62° and 65°C.; odor honey-like; taste faint but characteristic.

**Constituents.**—Hydrocarbons, myricyl palmitate, cerotic acid, cerin, two alcohols, aromatic substance, coloring matter, etc.

**Uses.**—Yellow wax is used in the preparation of ointments, cerates and plasters.

**Adulterants.**—(1) Tallow, which lowers its specific gravity and softens it; (2) Rosin, which dissolves in 75 per cent. hot alcohol and can be subsequently precipitated by the addition of water; (3) Paraffine; (4) Japan Wax; (5) Carnauba Wax.

## PHYLUM CHORDATA

A large group of typically bilaterally symmetrical metazoans which possess, either in their embryonic stages or throughout life, an endoskeletal axis or notochord, paired gill slits or pharyngeal clefts, and a dorsal, tubular, central nerve cord. This phylum is subdivided into the following subphyla: (1) Enteropneusta, (2) Tunicata, (3) Cephalochorda and (5) Vertebrata. The Vertebrata only yield drugs.

## SUB-PHYLUM VERTEBRATA

Vertebrates are animals which possess an axial notochord which, while persisting throughout life in some of the lower forms, becomes altered in higher vertebrates by an investment of cartilage. The cartilage later undergoes segmentation and in most forms partial replacement by bone, forming a series of bodies called vertebrae which collectively make up the vertebral column.

The vertebrates are grouped into the following classes: (1) Cyclostomata (lampreys and hagfishes), (2) Elasmobranchii (sharks and skates), (3) Pisces (fishes), (4) Amphibia (salamanders, newts, frogs and toads), (5) Reptilia (lizards, chameleons, turtles, snakes, alligators and crocodiles), (6) Aves (birds), and (7) Mammalia (mammals including whales, seals, bats, hairy quadrupeds, monkeys, anthropoid apes and man).

## CLASS ELASMOBRANCHII

Fish-like, cold blooded vertebrates with persistent notochord, cartilaginous skeleton, jaws and placoid scales. Sharks, rays and chimaeras.

## SHARK LIVER OIL N.N.R.

**Definition.**—The fixed oil extracted mainly from the livers of *Hypoprion brevirostris* but sometimes including oil from the livers of some species of other genera of sharks (Sub-order *Selachoides*).

**Standard of Assay.**—Not less than 16,500 U.S.P. units per gram of Vitamin A and not less than 40 U.S.P. units per gram of Vitamin D.

**Description.**—An amber to brown oily liquid having a fishy odor and taste; sp. gr. 0.917 to 0.925 at 25°C. Available in 30 and 120 cc. bottles.

**Uses.**—In Vitamin A deficiency diseases.

**Average Dose.**—0.3 cc. (5 minims).

**Preparation.**—Capsules Shark Liver Oil. Each capsule, containing 0.3 cc., supplies not less than 5000 U.S.P. units of Vitamin A.

## CLASS PISCES

The first class of vertebrates or backbone animals including many forms which are adapted to life in the water. The majority of fishes have an internal skeleton consisting chiefly of bone and a protective exoskeleton of dermal scales. Their respiratory organs consist of gills which are covered by gill covers or opercula. There are 2 subclasses, the *Teleostomi* or bony fishes and the *Dipnoi* or lung fishes.

## FAMILY GADIDÆ

A family of bony fishes (*Teleostomi*) comprising a number of valuable food fishes including the codfishes, haddocks, hakes and pollacks.

## COD LIVER OIL U.S.P. (OLEUM MORRHUÆ)

**Synonyms.**—Oleum Jecoris Aselli, Cod Oil; *Ger.* Leberthran; *Fr.* Huile de Foie de Morue.

**Zoological Origin.**—*Gadus morrhua* Linné and other species of the Family *Gadidæ*.

**Part Used.**—The partially destearinated fixed oil obtained from the fresh livers.

**Habitat.**—North Atlantic Ocean.

**Production and Commerce.**—The cod fish inhabits the cooler and deeper waters of the North Atlantic Ocean, visiting the coasts to spawn in the shallower waters during late winter and early spring. It is caught in vast numbers by trap nets, hand lines and set lines chiefly off the coasts of Norway, Newfoundland, Canada, New England, and Great Britain, where the cod fisheries are an important industry. The liver of the cod fish is its chief store house of fat. It is of a cream color on account of its high fat content and its lobes are of unequal size. It comprises about 5 per cent. of the total weight of the fish. The livers are removed while the fish are still fresh by hand gutting, care being exercised that the gall bladder is completely separated. They are then washed and the oil extracted usually by the direct steam process, rarely by subjecting livers to a gentle heat in iron pots, by cold expression or electrolysis.



In Newfoundland and New England, the direct steam process is almost exclusively employed. In this process the livers, after being washed, are placed in a steam pan and live steam is passed into them for approximately a half hour until the cells are ruptured and the oil comes out. The oil is then poured off and strained. This first fraction, known as "crude cod liver oil" or "ordinary refined oil" is marketed for medicinal purposes either as the non-destearinated oil of the U.S.P. or after refining and removing the stearin as *Oleum Morrhuae*. The residue is then pressed and the oil which separates is known as "common

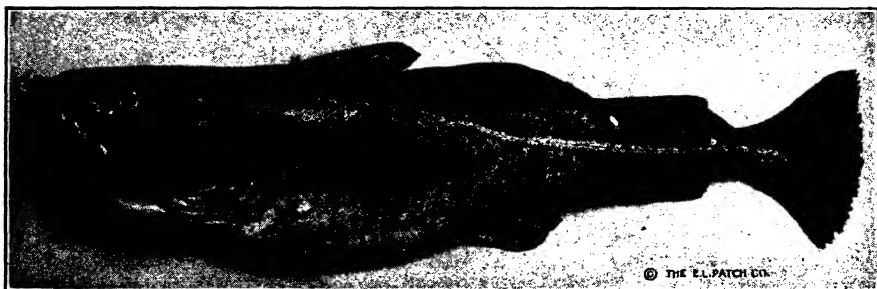


FIG. 497.—The Cod Fish (*Gadus morrhua*).

cod oil" and is used as a nutrient and tonic for poultry and other animals. Cod liver oil is refined by chilling it in tin vessels at a low temperature ( $-5^{\circ}\text{C}.$ ) which causes the stearin or solid fat to separate. The chilled oil is forced through a filter press which allows the clear oil to pass through and holds the stearin back in the frames. This refined product is official as "*Oleum Morrhuae*" in the U.S.P.

**Standards.**—The U.S.P. XIII requires that the Vitamin A and Vitamin D potency of Cod Liver Oil be expressed in U.S.P. units per gram of oil. The official standard is as follows: "Cod Liver Oil contains in each Gm. not less than 850 U.S.P. Units of Vitamin A and at least 85 U.S.P. Units of Vitamin D." It may be flavored by the addition of not more than 1 per cent of any flavoring substance or mixture of such flavoring substances recognized by the U.S.P. One U.S.P. unit of Vitamin A is equal, in growth promoting and antiophthalmic activities for the rat, to one International unit of Vitamin A. One U.S.P. unit of Vitamin D is equal, in antirachitic potency for the rat, to one International unit of Vitamin D. Both of these units have been defined and adopted by the Conference of Vitamin Standards of the Permanent Commission on Biological Standardization of the League of Nations in June 1931. The assays for Vitamins A and D comprise the recording of observations of groups of rats throughout specified periods of their lives, while being kept on specified dietary regimens, and the interpretation of such data. (For assays see U.S.P. XIII.) The International Unit for Vitamin A is 0.6 $\gamma$  (micrograms) of pure beta-carotene. Beta-carotene is obtained from carrots. The International Unit for Vitamin D is 0.025 $\gamma$  (micrograms) of crystalline calciferol. Calciferol is the same as irradiated ergosterol or Vitamin D<sub>2</sub>.

The Cod Liver Oil used in this country in normal times comes chiefly from Norway, Newfoundland and New England.

**Description.**—A pale yellow, thin oil with a slightly fishy but not a rancid odor and a fishy taste, slightly soluble in alcohol and completely soluble in chloroform, ether, carbon disulphide and ethylacetate. Specific gravity: 0.918 to 0.927 at 25°C.

**Constituents.**—*Vitamin A* (fat soluble), *Vitamin D*, traces of iodine and bromine organic compounds; jecolein, therapin, palmatin, biliary acids, choles-



FIG. 498.—Cod Liver. The liver is the store house of fat for the cod fish. The liver is cream colored on account of its high fat content and its lobes are of unequal size.

terin, the alkaloids, aselline and morrhuine, etc. The presence of more than traces of biliary acids, asseline and morrhuine indicate oil unsuitable for medicinal use. Vitamin A represents the growth-promoting and antixerophthalmic element, whereas Vitamin D represents the antirachitic element of this oil.

**Uses.**—Cod Liver Oil is used as a nutritive and growth stimulating agent in rickets, malnutrition, tuberculosis, dental caries and in convalescence from respiratory diseases.

**Average Dose.**—Infants and adults, 8 cc. (2 fl. dr.). Cod Liver Oil containing more than the minimum U.S.P. requirements for Vitamin A and Vitamin D may be administered in proportionately smaller doses.

**Adulterants.**—Seal oil and other fish oils, undestearinated cod liver oil and free fatty acids.

**Preparation.**—Cod Liver Oil Emulsion, U.S.P., Infants and adults, 15 cc., Cod Liver Oil Emulsion with Malt (*Malt and Cod Liver Oil*), N.F., 15 cc.

NON-DESTEARINATED COD LIVER OIL U.S.P. (OLEUM MORRHUÆ NON-DESTEARINATUM)

**Definition.**—The entire fixed oil obtained from fresh livers of *Gadus morrhua* L. and other species of the Family *Gadidae*, containing not more than 0.5 per cent. by volume of water and liver tissue.

**Standard of Assay.**—It contains in each Gm. not less than 850 U.S.P. Units of Vitamin A and not less than 85 U.S.P. Units of Vitamin D.

The Vitamin A potency and Vitamin D potency of this oil, when designated on the label, shall be expressed in U.S.P. Units per gram of oil.

**Description.**—A thin, oily liquid at normal room temperature, possessing a peculiar, slightly fishy, but not a rancid odor, and a fishy taste. It congeals or deposits stearin on chilling.

**Uses.**—Similar to Oleum Morrhuae, but chiefly for administration to poultry and other farm animals.

#### FAMILY PLEURONECTIDÆ

Bony fishes whose bodies are flattened from side to side and so adapted to living on the bottom of seas. It includes the halibuts, flounders, soles, plaice and turbot.

#### HALIBUT LIVER OIL U.S.P. (OLEUM HIPPOGLOSSI)

**Definition.**—The fixed oil obtained from the fresh or suitably preserved livers of *Hippoglossus hippoglossus* Linné. It may be flavored by the addition of not more than 1 per cent. of any one or a mixture of flavoring substances recognized by the U.S.P.

**Standard of Assay.**—Halibut Liver Oil contains in each Gm. not less than 60,000 U.S.P. units of Vitamin A and not less than 600 U.S.P. units of Vitamin D.

**Animal.**—The halibut is a large flat fish up to 8 ft. in length and weighing up to 400 pounds. It is native to the north Atlantic and Pacific Oceans. Its body is thick and elongated, its left side upon which it lies on the sea-bottom is white while the right side is dark brown and bears both eyes in the mature fish. Its liver is smaller than that of the cod of similar size and yields less oil, but the oil is much higher in content of Vitamins A and D than cod liver oil.

**Description.**—A yellow to brownish-yellow oily liquid, possessing a peculiar slightly fishy odor and a fishy taste; sp. gr. 0.920 to 0.930 at 25°C.

**Identity Test.**—When a solution of 1 drop of Halibut Liver Oil in 1 cc. of chloroform is shaken with 1 drop of sulfuric acid it acquires a blue color changing to violet, dark green and finally brown.

**Constituents.**—Vitamin A, Vitamin D, olein, palmitin, cholesterin, etc.

**Uses.**—Nutritive and growth-stimulating agent in vitamin deficiencies.

**Average Dose.**—Infant and Adult, daily, as a prophylactic, 0.1 cc. (1½ minims). Halibut Liver Oil containing more than the U.S.P. minimum requirements for both Vitamin A and Vitamin D may be given in proportionately smaller doses.

**Preparation.**—Halibut Liver Oil Capsules (Capsulæ Olei Hippoglossi), U.S.P. These capsules shall be labeled to contain either 5000 or 25,000 U.S.P. Units of Vitamin A per Capsule. Av. daily prophylactic dose, 1 capsule containing 5000 U.S.P. Vitamin A units. The dose of the 25,000 Vitamin A-unit Capsules is to be determined by the physician, according to the needs of the patient.

**Other Fish Liver Oils.**—**Percomorph Liver Oil** (*Oleum Percomorphum*), **N.N.R.** consists of a mixture containing fixed oils obtained from the fresh livers of percomorph fishes, principally the sword-fish, *Xiphias gladius*, the tuna, *Thunnus thynnus*, the *Pneumatophorus diego* and *Stercolepis gigas*. It contains not more than 50 per cent of other fish liver oils. Its potency is not less than 60,000 U.S.P. Units of Vitamin A per gram and not less than 8,500 U.S.P. Units of Vitamin D per gram. It is used for the same purposes as Cod Liver Oil. Dose, prophylactic for normal infants, 10 drops daily; curative and in severe conditions, up to 20 drops daily.

**Burbot Liver Oil, N.N.R.**—The fixed oil extracted from livers of the Burbot, *Lota maculosa* LeSueur (Fam. *Gadidæ*). Its potency is not less than 4,480 U.S.P. Units of Vitamin A per gram and not less than 640 U.S.P. Units of Vitamin D per gram. It is used for the same purposes as Cod Liver Oil. Dose, prophylactic, 1 cc. (40 drops) daily.

### CLASS REPTILIA

Reptiles are cold blooded vertebrates which breathe by lungs and whose bodies are covered by scales or bony plates.

### ORDER SQUAMATA

To this order belong the snakes, lizards and chameleons which possess horny epidermal scales, movable quadrate bones and procoelus vertebræ. The snakes belong to the suborder Serpentes. They are elongated reptiles without limbs, pectoral girdle or urinary bladder. The right and left halves of their lower jaws are not firmly joined but connected by an elastic ligament.

### FAMILY VIPERIDÆ

This family includes thick-bodied, poisonous snakes of the eastern and western hemispheres. The true vipers are native to the Old World and belong to the sub-family *Viperinæ*; the pit vipers are natives of the New World and belong to the sub-family *Crotalinæ*. The pit vipers are represented in North America by the rattlesnakes (*Crotalus*), the copperhead (*Agkistrodon mokasen*) and the water moccasin (*Agkistrodon piscivorus*). They possess a deep pit on each side of the head between the eye and nostril, a slender neck and a flat, triangular head; their upper jaw is devoid of solid teeth, but possesses a pair of long poison fangs, each pierced by a canal which opens near its tip. The fangs lie against the roof of the mouth when not in use, but are erected or projected forward when the serpent strikes. They are connected with a pair of poison glands which lie above the roof of the mouth which open into poison ducts and these into the fangs. Their eye pupils are vertical. Viviparous.

### ANTIVENIN (CROTALUS) N.N.R.

**Synonyms.**—*Crotalus Antitoxin*, North American Anti-Snake Bite Serum.

**Definition.**—An antitoxic serum prepared by immunizing animals against the venom of snakes of the *Crotalus* family.

**Production.**—Venins are exotoxins produced by snakes, toads and scorpions. Antivenins are antitoxins which are specific for the venoms from which they were prepared. Snake venoms are obtained by irritating poisonous snakes held facing a sheet of paper which is tied over a conical glass container. The snake strikes the paper which is penetrated by its fangs, and the semiliquid poison is ejected into the container. For this product which represents a polyvalent antivenin, the venoms of rattlesnakes, the copperhead and the water moccasin are first obtained and mixed. They are then desiccated in an incubator. The dried venom is subsequently dissolved in equal parts of glycerin and normal saline solution and placed in a refrigerator for one month. Horses, or if not available, mules, goats or cows are then repeatedly injected subcutaneously in gradually increasing doses with the solution of the venom until immunity is established. The animal is then bled from the jugular vein and the blood is collected in a sterile receptacle. The blood is then processed to separate the serum and the serum concentrated by the salting out process similar to that used in preparing diphtheria antitoxin. Potency is determined by tests on pigeons, rabbits or mice. The usual precautionary measures observed in preparing and marketing other antitoxins and sera are also carried out with this product. The product is marketed in syringes containing 10 cc.

**Use.**—To neutralize the venins or poisons injected through the bites of copperheads, water moccasins or rattlesnakes.

**Dose.**—*Crotalus* Antitoxin is administered intramuscularly and subcutaneously in doses ranging from 10 cc. to 50 cc.; first aid measures including incision, suction of the wound and the application of a tourniquet or ligature above the bite promptly, as soon as possible after being bitten, should also be carried out. The antitoxin can be administered intravenously in cases seen late or in the presence of severe symptoms.

## CLASS AVES

Birds are warm blooded vertebrates which differ from all other vertebrates by possessing feathers. Their forelimbs are modified as wings and their young are hatched from eggs (oviparous).

### FAMILY PHASIANTIDÆ

Fowl-like birds of terrestrial or tree habit with a stout, convex beak, short, rounded wings and short, stout legs having toes adapted for scratching. To this family belong most of our game-birds including the chickens, quail, bob-whites, partridges, grouse and turkeys.

### OVUM (EGG)

**Synonyms.**—Ovum Gallinaceum, Hen's Egg, Chicken's Egg; *Fr.* Œuf frais; *Ger.* Frisches Ei.

**Zoological Origin.**—*Gallus domesticus* Temminck.

**Part Used.**—The recently laid egg of the hen.

**Habitat.**—Probably descended from the red jungle fowl, indigenous to India and other Asiatic countries.

**Description.**—Ovate and consisting of a thin calcareous shell enclosing a thin membrane which surrounds albuminous matter or egg white that in turn envelops the vitellus or egg yolk.

From this egg the shell or *Testa Ovi*, the white of egg, and the egg yolk or yolk are obtained.

**Constituents.**—Egg-shell is composed of from 90 to 97 per cent. of pure calcium carbonate, the remainder consisting of magnesium and calcium phosphates and organic matter.

Egg-white is composed of about 15 per cent. albumin and 85 per cent. of water with minute traces of sodium and potassium chlorides, fat and sugar.

Egg-yolk contains about 30 per cent. of fat, 16 per cent. vitellin, 52 per cent. water, 1.5 per cent. inorganic salts, traces of lactic acid and sugar, and coloring matter.

**Uses.**—The shell was formerly used as an antacid. Egg-white is used as a nutrient and as an ingredient of Canada liniment. Egg-yolk is used as an emulsifying agent and in the preparation of Glycerite of egg-yolk and, together with the contents of eggs, in St. John Long's liniment. Fertile eggs containing 6-to-7-day old chick embryos are used in the preparation of Epidemic Typhus and Yellow Fever vaccines.

**Preparation.**—Acetic Turpentine Liniment, N.F. (*Linimentum Terebinthinæ Aceticum*) (from egg).

## CLASS MAMMALIA

The members of this class of vertebrates breathe by means of lungs, and are warm-blooded. Hair at some period in their life history is also present, and the young are nourished after birth by secretions from cutaneous glands. The heart is composed of four chambers, two ventricles and two auricles. There is a single left aortic arch and the blood contains non-nucleated erythrocytes. With the exception of the monotremes of Australia all are viviparous. Examples: Marsupials, Manatees, Armadillos, Moles, Rodents, Cattle, Sheep, Swine, Apes, Whales, Man, etc.

## ORDER ARTIODACTYLA

Terrestrial and largely herb-feeding animals with more or less hair and with an even number of hoofed toes. The canine teeth are generally small or entirely absent, while the molars and premolars which are used in grinding are well developed and have broad crowns with roughened surface. There is no foramen over the inner condyle of the humerus, and the clavicle is absent.

## FAMILY BOVIDÆ

Ruminants having hollow, unbranched horns, not shed each year, and which fit over bony projections on the skull. The stomach as a general rule is complex. Examples:—chamois, goats, musk-oxen, cows, gazelles, gnus, bison, sheep, oxen, etc.

## LIVER EXTRACT U.S.P. (EXTRACTUM HEPATIS)

**Synonym.**—*Dry Liver Extract*, Extract of Liver.

**Definition.**—Extract of Liver is a dry, brownish, hygroscopic powder and contains that soluble thermostable fraction of mammalian livers which increases the number of red blood corpuscles in the blood of persons affected with pernicious anemia. Its approximate anti-anemia potency in pernicious anemia is expressed in U.S.P. Units. It conforms to all other requirements outlined under *Anti-anemia Preparations* in the U.S.P.

Various concentrates and extracts of liver have been marketed by pharmaceutical manufacturers under trade names. Some of these are for oral, others for intravenous or intramuscular administration.

**Use.**—In pernicious anemia. **Av. Daily Dose.**—1 U.S.P. Unit.

## LIVER INJECTION U.S.P. (INJECTIO HEPATIS)

**Synonyms.**—Liver Extract for Parenteral Use.

**Definition.**—A sterile solution in water for injection of that soluble thermostable fraction of mammalian livers which increases the number of red blood corpuscles in the blood of persons affected with pernicious anemia.

**Standards.**—Liver Injection contains either 10 U. or 15 U.S.P. Units (Injectable) in each cc. It contains not more than 0.5 per cent of cresol or of phenol if either is used as a bacteriostatic agent.

**Preservation.**—It must be preserved in single dose, hermetic containers or other suitable containers at a temperature not above 20°C., protected from light.

**Use.**—In pernicious anemia.

**Average Dose.**—Intramuscular, 1 U.S.P. Unit, daily.

## LIVER SOLUTION U.S.P. (LIQUOR HEPATIS)

**Synonym.**—Liquid Liver Extract.

**Definition.**—Liver Solution is a brownish liquid and contains that soluble thermostable fraction of mammalian livers which increases the number of red blood corpuscles in the blood of persons affected with pernicious anemia.

**Standards.**—The approximate anti-anemia potency of Liver Solution is expressed in U.S.P. Units (Oral). It must be labeled to show the potency assigned to it by the Anti-anemia Preparations Advisory Board of the U.S.P.

**Preservation.**—Preserve in tight, light-resistant containers preferably at a temperature not above 20°C.

**Average Dose.**—1 U.S.P. Unit (Oral), daily.

## LIVER WITH STOMACH U.S.P. (HEPAR CUM STOMACHO)

**Definition.**—A brownish powder resulting from mixing a concentrated water solution of mammalian liver with minced fresh hog stomach tissue.

**Production.**—The fraction of liver used (Cohn fraction D) is soluble in approximately 70 per cent alcohol and insoluble in approximately 95 per cent

alcohol. It is mixed with minced fresh stomach or stomach linings of hogs, the hydrogen-ion concentration adjusted to pH<sub>5</sub>, incubated for about two hours at 37.5°C. and allowed to digest. It is then spread out in a thin layer on pans and dried under reduced pressure, defatted, dried under vacuum and powdered.

**Standards.**—The approximate anti-anemia potency of Liver with Stomach in pernicious anemia is expressed in U.S.P. Units (Oral).

**Average Dose.**—1 U.S.P. Unit, daily. **Preparation.**—Capsules.

**Allied Product.**—**Extralin N.N.R.**—A liver-stomach concentrate resulting from the interaction of a mammalian concentrated liver extract containing the Cohn fraction D and stomach tissue material. When assayed in cases of pernicious anemia, the daily oral administration of 6 Gm. has been found to produce the standard reticulocyte response defined as 1 U.S.P. unit (oral). **Dosage.**—For cases of pernicious anemia in relapse, 2 Gm. (4 pulvules) three times a day; maintenance dose, 1.5 Gm. (3 pulvules) three times daily.

#### OX BILE (FEL BOVIS)

**Synonyms.**—Ox Gall; *Ger.* Ochsen-galle; *Fr.* Bile de boeuf.

**Zoological Origin.**—*Bos taurus* Linné.

**Part Used.**—The fresh bile.

**Description.**—A dark green or brownish-green, somewhat viscid, neutral or faintly alkaline liquid, having a characteristic odor and a disagreeable, bitter taste. Its specific gravity ranges from 1.015 to 1.025 at 25°C.

**Constituents.**—*Sodium and potassium glycocholates and taurocholates*, bilirubin and biliverdin (bile pigments), cholesterolin, lecithin, choline, fat, urea, etc.

**Use.**—Choleretic and cholagogue cathartic usually in the form of the extract, *Extractum Fellis Bovis U.S.P.* It is also employed for cleaning cloth and as a constituent of Brilliant Green-Bile-Lactose Peptone N.F.

#### OX BILE EXTRACT U.S.P. (EXTRACTUM FELLIS BOVIS)

Ox Bile Extract (*Powdered Oxgall Extract*) is a brownish-yellow, greenish-yellow or brown powder having a bitter taste. It is soluble in water and in alcohol and its solutions foam strongly when shaken. It contains Na salts of ox bile acids equivalent to not less than 45 per cent. of *cholic acid*. Cholagogue in chronic constipation, hepatic torpor, etc. **Av. dose**, 0.3 Gm. (5 grains). **Preparation.**—Ox Bile Extract Tablets, U.S.P., 0.3 Gm. (5 grains).

**Allied Drugs.**—**Bile Salts N.N.R.** represents a preparation obtained from fresh ox bile and consisting of sodium glycocholate and sodium taurocholate in the proportion existing in ox bile. It is used to promote the intestinal absorption of fats and fat-soluble vitamins and as a choleretic. **Dose.**—30 mg. to 0.2 Gm.

**Dehydrocholic Acid N.N.R.** (Decholin) is an oxidation product of cholic acid derived from natural bile acids. It is used to increase the volume of bile, as a diuretic in combination with mercury compounds in edema of cardiac origin, etc.



## THROMBIN N.N.R.

**Thrombin** or Thrombin, Topical is a preparation consisting of a mixture of thrombin and sucrose. It is a standardized, sterile hemostatic powder containing thrombin isolated from the blood plasma of cattle.

**Standard.**—Not less than 10 units of thrombin per milligram of total solids. A unit of thrombin possesses the power to clot 1.0 cc. of fibrinogen solution in  $15 \pm 0.5$  seconds at  $28^\circ \pm 1^\circ\text{C}$ . when tested by the method of the National Institute of Health.

**Description.**—A white powder completely soluble in water or isotonic solution of sodium chloride.

**Coagulation of Blood.**—The clotting of blood is brought about by the formation of fibrin. Fibrin is derived from fibrinogen under the influence of a ferment-like substance called thrombin and calcium salts. Thrombin as such does not occur in circulating blood but a precursor or mother of thrombin occurs there which is known as prothrombin. In order that prothrombin may be transformed into active thrombin, it must be acted upon by another substance called thromboplastin in the presence of calcium. Thromboplastin is derived from disintegrated blood platelets and injured tissue cells. Prothrombin is prevented from becoming active in the blood stream owing to its being bound to another substance called antithrombin. The thromboplastin breaks up the combination liberating prothrombin. The free prothrombin is activated into thrombin by calcium. Fibrinogen is then transformed by thrombin into fibrin. The fibrin entangles the corpuscles and forms the clot.

**Uses.**—Thrombin is a powerful hemostatic forming a clot by directly converting fibrinogen to fibrin. It is used as a local hemostatic to control capillary bleeding in surgery, in epistaxis, tooth extraction, brain operations, skin grafting, prostatectomy, tonsillectomy, hemorrhoidectomy, etc. It may be applied in the dry form or dissolved in sterile isotonic salt solution. It is available in ampuls containing 5,000 units of thrombin, packaged with a 5 cc. vial of sterile isotonic salt solution.

## COW'S MILK (LAC VACCINUM)

**Synonyms.**—Milk; *Ger.* Milch; *Fr.* Lait.

**Zoological Origin.**—*Bos taurus* Linné.

**Definition.**—The fresh unpasteurized or pasteurized milk of the domestic cow without modification, and complying with the legal standards of the State or community in which it is sold.

**Constituents.**—Casein and other proteins, fat, lactose, nuclein and lecithin, vitamins, etc., in a perfect emulsion with water.

**Uses.**—Nutrient. Pharmaceutically as a source of Lactosum U.S.P. and in the preparation of Fermented Milk or Kumyss.

**Average Dose of Kumyss.**—250 cc. (8 fluid ounces).

## LACTOSE U.S.P. (LACTOSUM)

**Synonyms.**—*Saccharum Lactis*, Milk Sugar, Sugar of Milk; *Ger.* Milchzucker; *Fr.* Sucre de Lait.

**Zoological Origin.**—*Bos taurus* Linné.

**Part Used.**—A sugar,  $C_{12}H_{22}O_{11} \cdot H_2O$ , obtained from milk.

**Production.**—Lactose is produced largely in the United States, Switzerland and the Bavarian Alps as a by product of cheese manufacture. It is made from the whey of cows' milk.

**Description.**—It occurs in white, hard, crystalline masses or as a white powder; odorless; taste faintly sweet, producing a gritty sensation to the tongue.

**Uses.**—Nutrient, especially in infant feeding. A diluent in prescriptions and in the manufacture of pharmaceutical preparations.

**Adulterants.**—Sucrose. Starch. Dextrose. Heavy metals.

#### WOOL FAT U.S.P. (ADEPS LANÆ)

**Synonyms.**—*Anhydrous Lanolin*, *Refined Wool Fat*; *Ger.* Wollfett; *Fr.* Suint de laine.

**Zoological Origin.**—*Ovis aries* Linné.

**Part Used.**—The purified, anhydrous, fat-like substance from the wool of sheep.

**Habitat.**—Domesticated.

**Description.**—A brownish-yellow, sticky, unctuous mass with only a slight odor; it mixes without separation with about twice its weight of water and melts between  $36^{\circ}$  and  $42^{\circ}C$ .

**Constituents.**—*Cholesterol* and *ischolesterol* (monohydric alcohols) in combination with lanoceric, lanopalmitic and other fatty acids.

**Uses.**—In the preparation of *Adeps Lanæ Hydrosus* U.S.P. (Hydrous Wool Fat) or Lanolin which is wool fat incorporated with 25 to 30 per cent. of water. The latter is employed as an inunction and vehicle for medicines intended for local application.

#### PREPARED SUET N.F. (SEVUM PRAEPARATUM)

**Synonyms.**—*Mutton Suet*, Prepared Mutton Tallow, *Sebum Ovillum*; *Ger.* Talg; *Fr.* Suif de Mouton Purifié.

**Zoological Origin.**—*Ovis aries* Linné.

**Part Used.**—The internal fat of the abdomen of the sheep, purified by melting and straining.

**Description.**—A white, solid fat which, when fresh, has a slight distinctive odor and a bland taste. On exposure to the air for a long time it becomes rancid and must not be used. It melts at about  $48^{\circ}C$ .

**Constituents.**—Chiefly stearin with some palmitin and olein.

**Uses.**—Emollient and base for some ointments. Enters into Benzoinated Suet.

#### RENNIN N.F. (RENNINUM)

Rennin is the partially purified milk-curdling enzyme obtained from the glandular layer of the stomach of the calf, *Bos taurus* Linné.

**Standard.**—Rennin possesses a coagulating activity of not less than 90 per cent. and not more than 110 per cent. of Reference Rennin N.F. Reference

Rennin is a repeatedly tested, stable, powdered rennin capable of coagulating not less than 25,000 times its weight of fresh cow's milk. Rennin of higher coagulating power may be brought to the standard by admixture with sodium chloride or lactose or both.

**Description.**—It occurs as a grayish-white or yellowish-white powder, or as pale yellow grains or scales possessing a distinctive saline taste and a peculiar odor. It is slowly soluble in water and diluted alcohol. It shows no cellular structure, and no blue coloration occurs when it is examined in iodine mounts under the microscope.

**Uses.**—Digestant. A constituent of Pepsin Essence N.F.

**Preparation.**—Pepsin and Rennin Elixir (Elixir Pepsini et Rennini), N.F., 8 cc.

#### FAMILY SUIDÆ (PIG FAMILY)

A family of non-ruminant ungulates with very thick skin bearing bristle-like hairs, with incisor, canine, premolar and molar teeth in both jaws and devoid of horns.

#### LARD U.S.P. (ADEPS)

**Synonyms.**—Hog's Lard, Prepared Lard; *Ger.* Schweineschmalz; *Fr.* Graisse, Axonge.

**Zoological Origin.**—*Sus scrofa* var. *domesticus* Gray.

**Part Used.**—The purified internal fat of the abdomen of the hog.

**Habitat.**—Domesticated from the wild boar.

**Production.**—The fat tissue is cut from the mesentery, omentum and from around the kidneys of hogs, deprived of membranes and blood vessels by hand, cut into pieces and washed with water. It is then rendered in vessels over a low fire or on a water bath, or more frequently, on the large scale, in tanks, by steam heat. The rendered lard is then strained through linen or flannel. Lard is rendered inodorously by melting it on a salt water bath with a little added alum and salt.

**Description.**—A soft, white, unctuous substance, having a faint odor and a bland taste; insoluble in water, very slightly soluble in alcohol, readily soluble in ether, chloroform and petroleum benzin. It melts between 36° and 42°C.

**Constituents.**—From 50 to 60 per cent. of olein; stearin and palmitin.

**Uses.**—Emollient and as a base for ointments and cerates; in Benzoinated Lard U.S.P.

**Impurities.**—Water, sodium chloride, free fatty acids.

**Adulterants.**—Cottonseed oil and beef fat.

#### POWDERED STOMACH U.S.P. (STOMACHUS PULVERATUS)

**Synonyms.**—*Dried Stomach*, Desiccated Hogs' Stomach, Stomachus.

**Definition.**—The dried and powdered defatted wall of the stomach of the hog, *Sus scrofa* L. var. *domesticus* Gray (Fam. *Suidæ*). It contains factors which cause an increase in the number of red blood corpuscles in the blood of persons affected with pernicious anemia.

**Standard.**—The approximate anti-anemia potency of Powdered Stomach in pernicious anemia is expressed in U.S.P. Units (oral). P. Stomach must conform to the specifications outlined under Anti-anemia Preparations (see U.S.P., p. 617), which indicate that the product must be approved by the U.S.P. Anti-anemia Preparations Advisory Board after complying with specifications which include satisfactory clinical data from treatment with the product in question of cases of Addisonian pernicious anemia and that the administration of the material in question can produce a satisfactory hematopoietic and clinical response, labeling requirements, etc.

**Uses and Dose.**—In primary and pernicious anemia, the dosage to be determined by the condition of the patient. **Average Daily Dose.**—1 U.S.P. Unit.

#### PEPSIN N.F. (PEPSINUM)

**Synonyms.**—*Ger.* Pepsin; *Fr.* Pepsine.

**Zoological Origin.**—*Sus scrofa* L. var. *domesticus* Gray.

**Part Used.**—A substance containing a proteolytic enzyme obtained from the glandular layer of the fresh stomach of the hog.

**Standard of Assay.**—Pepsin, when assayed by the method directed by the N.F., digests not less than 3000 and not more than 3500 times its weight of egg albumen. Pepsin of a higher digestive power may be brought to this standard by admixture with pepsin of a lower power or with lactose.

**Preparation.**—Most of the pepsin in use today is scale pepsin. This is prepared as follows: The mucous membrane lining of hogs' stomachs is washed, minced and then digested with about 0.2 per cent. hydrochloric acid until the membrane is dissolved. The solution is neutralized by an alkali, filtered or strained and evaporated *in vacuo* or at a low temperature to a syrupy consistence. The syrupy liquid is spread on glass plates and dried in a current of warm air at a temperature not exceeding 40°C. The substance containing the pepsin crystallizes out in scales and is scraped off.

**Description.**—It occurs in weak yellow to pale brown transparent or translucent scales, granules or spongy masses, or as a white or cream-colored amorphous powder, with a faint but inoffensive odor and a slightly acid or salty taste; freely soluble in water, the solutions being more or less opalescent. Dry pepsin is not injured by heating to 100°C. The activity of Pepsin in solution is destroyed by alkalis or by temperatures higher than 70°C.

**Uses.**—Digestant, and in the relief of nausea from salicylates, iodides, etc.

**Average Dose.**—0.5 Gm. (7½ grains).

**Preparations.**—Pepsin and Rennin Elixir (Elixir Pepsini et Rennini), N.F., 8 cc. (2 fl. dr.); Compound Pepsin Elixir, N.F., 8 cc.; Pepsin Elixir N.F., 8 cc.; Saccharated Pepsin, N.F., 1 Gm.

#### PANCREATINUM U.S.P. (PANCREATIN)

**Synonyms.**—Zymine; *Fr.* Pancreatine médicinale; *Ger.* Pankreatin.

**Zoological Origin.**—*Sus scrofa* L. var. *domesticus* Gray and *Bos taurus* Linné.

**Part Used.**—A substance containing enzymes, principally pancreatic amylase, trypsin and pancreatic lipase obtained from the fresh pancreas of the hog or ox.

**Standard of Assay.**—It converts not less than 25 times its weight of U.S.P. Potato Starch Reference Standard into soluble carbohydrates and not less than 25 times its weight of casein into proteoses. Pancreatin of a higher digestive power may be brought to this standard by admixture with lactose or with sucrose containing not more than 3.25 per cent of starch, or with pancreatin of lower digestive power.

**Preparation.**—The pancreas of the hog or ox is cleaned, chopped fine and mixed with cold water, the liquid being strained by pressure through cheese cloth or flannel. The strained liquid is treated with alcohol which precipitates the substance containing the enzymes. The precipitate is collected, dried and powdered. It should be stored in tight containers, preferably at a temperature not above 30°C.

**Description.**—A cream colored, amorphous powder having a faint distinctive but not offensive odor and meat-like taste; slowly soluble in water, insoluble in alcohol.

**Use.**—Digestant. The Compound Powder of Pancreatin is used for peptonizing milk.

**Average Dose.**—0.5 Gm. ( $7\frac{1}{2}$  grains).

**Preparation.**—Pulvis Pancreatini Compositus, N.F. VII (Peptonizing Powder).

#### FAMILY MOSCHIDÆ

Small, antlerless deer with short tail and fairly high hind quarters. Canine teeth are well developed and, in the male, project from the upper jaw. The musk sac is located between the umbilicus and the preputial follicles.

#### MOSCHUS (MUSK)

**Synonyms.**—Tonquin Musk, Deer Musk; *Fr.* Musc; *Ger.* Bisam.

**Zoological Origin.**—*Moschus moschiferous* Linné.

**Part Used.**—The dried secretion from the musk sac.

**Habitat.**—In forests of the Himalaya mountains from India to Siberia.

**Animal.**—One of the members of the *Moschidæ*, inhabiting the highlands and plateaus of central Asia, especially Thibet. The male is about a yard in length and 20–22 inches in height, and its coat is brownish with white underparts. The musk sac is as large as a hen's egg and somewhat flattened on one side. It is lined by a convoluted, smooth membrane which secretes musk. In the case of the doe, the musk-sac is absent, and the deer is smaller than the male. The largest herds of musk-deer are found on the southern shores of the Koro-Nor.

**Production and Commerce.**—Musk is secreted in the hairy musk sac located between the umbilicus and the preputial follicles of the male musk deer. It is a brown, thick secretion, when first collected, and occurs in quantities up to 25 Gm. in the sac of the adult animal. It is collected, after trapping and

killing the animal, by cutting off the sac and quickly drying by pressing against heated stones. Autumn and winter collected musk is considered the best. The chief markets for musk are Sungpan, Tachienlu and Yuchow. The sacs are packed in small rectangular cases lined with tin foil and shipped via Shanghai or Calcutta to purchasers in Europe and the United States. China is the chief exporter of musk.

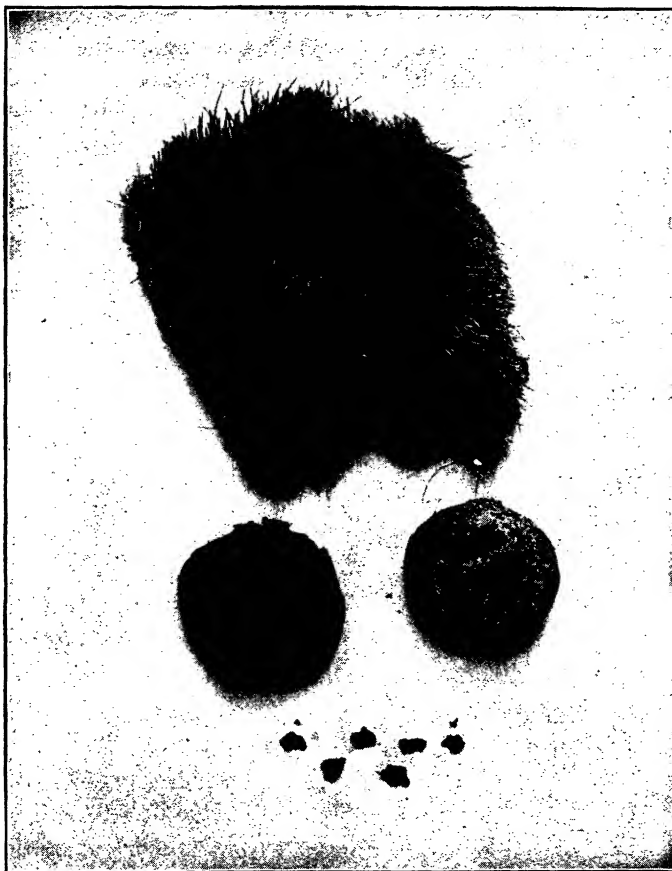


FIG. 499.—*Moschus*. Entire musk sac and contents,  $\times \frac{1}{4}$ . (Photograph by Stoneback.)

**Description.**—In small, irregular, oily and glistening granules, not more than 2 mm. in thickness, blackish or brownish, becoming grayish on ageing; odor peculiar, penetrating, powerful and persistent; taste somewhat bitter. Not less than 50 per cent. of musk should be water-soluble.

If a few granules of musk be added to a small quantity of chloroform in a watch crystal, the grains float on the surface; upon stirring with a glass rod the solution remains nearly colorless, and as it evaporates a small quantity of a whitish oily substance separates around the particles.

**Constituents.**—A dark brown *volatile oil* containing a cyclic ketone called *muskone* ( $C_{15}H_{30}O$ ); resin, cholesterin, protein, fat, calcium and ammonium compounds, etc. Muskone is the principal odoriferous constituent.

**Uses.**—Musk is employed chiefly in the manufacture of perfumery. Its U.S.P. IX tincture (5%) has been used as an antispasmodic in hiccough, nerve exhaustion, etc.

**Average Dose.**—0.25 Gm. (4 grains); Tinct. 1 fl. dr.

**Adulterants.**—(1) Starch, detected by mounting crushed granules on a slide adding iodine and examining under a microscope and noting bluish stained granules. (2) Artificial musks including xylene-, ketone-, aldehyde-, cyano- and azido-musk, and musk ambrette, all insoluble in water but soluble in alcohol. (3) Peas. (4) Barley. (5) Acorns. (6) Fried liver. (7) Powdered beef. *American Musk*, used as a substitute in perfumery, is obtained from the muskrat, *Fiber zibethicus* L.

#### ORDER CARNIVORA

Chordates in which the young are nourished in the uterus of the mother for a time. Integument furry. Four or more digits developed on the fore and hind feet, all provided with claws. Clavicle absent or incomplete. The canine teeth are generally large, curved and pointed. Molar and premolars compressed and the incisors are small and chisel-like. The stomach is not complex and the brain fairly large. Examples—Cats (*Felidæ*), Bears (*Ursidæ*), Otters (*Lutridæ*), Walruses (*Trichechidæ*), Civets (*Viverridæ*) etc.

#### FAMILY VIVERRIDÆ

Small cat-like, carnivorous quadrupeds with, as a rule, short legs, a curly tail, a long body, and a sharp snout. The family is naturally divided into the aeluropod type or cat-footed, and the cynopod or dog-footed. Both types are instrumental in destroying vermin.

#### CIVET (CIVETTA)

**Synonyms.**—Zibethum; *Ger.* Zibeth; *Fr.* Civette.

**Zoological Origin.**—1. *Viverra civetta* Schreber and 2. *Viverra zibetha* Schreber.

**Part Used.**—Unctuous secretion obtained from a pouch situated between the anus and genitalia of both male and female civets.

**Habitat.**—(1) Africa. (2) Southern Asia.

**Production and Commerce.**—Civet is secreted by the scent glands into a compressible pouch found under the tail of the civet cat near the genitalia. Most of the product is gathered in Abyssinia by the natives who, after catching the cats, keep them in cages and feed them on fresh meat. During captivity the secretion increases. In gathering the secretion the animal is held tight in its cage, and the contents of the civet pouch removed with an ivory or bamboo spatula. Collection of the secretion is made from the cat several times a week, the weekly yield of civet from the average cat being reported by Couderchet to be 3 to 4 Gm. Poultry-fed civet cats are stated to yield a superior article of a

whitish color. As the product is collected it is packed into zebu horns and sold to travelling dealers who carry the drug by caravan to Addis Ababa from whence it is carried by rail to the coast and exported to the United States, France, Yemen and the Persian Gulf.

**Description.**—A yellowish to brownish, unctuous substance having a penetrating odor resembling musk; yellowish when fresh; taste bitter and acrid.

**Constituents.**—An unsaturated cyclic ketone called *civetone*, *volatile oil*, resin, coloring matter, etc.

**Use.**—Civet is used chiefly by the perfume industry as a fixative. It is also employed by the Arab women as a cosmetic.

### ORDER PRIMATES

Mostly arboreal mammals inhabiting chiefly the warmer parts of the world. Hands and feet adapted for grasping owing to great toe and thumb being opposable to the other digits.

### FAMILY HOMINIDÆ

The human family differing from other primates in the larger size of the brain, in the ability to reason, in the less developed hairy covering and in bipedal locomotion.

#### NORMAL HUMAN SERUM U.S.P. (SERUM HUMANUM NORMALE)

**Synonym.**—Human Serum.

**Definition.**—Normal Human Serum is the sterile serum obtained by pooling approximately equal amounts of the liquid portion of coagulated whole blood from 8 or more humans (*Homo sapiens* L.) who have been certified by a qualified doctor of medicine as free from any disease which is transmissible by blood transfusion at the time of drawing the blood.

**Production.**—Each bleeding is drawn under aseptic precautions into individual sterile centrifuge bottles and allowed to coagulate for at least 12 hours and not more than 24 hours. The serum, free from blood corpuscles, is then separated by centrifugation, and transferred to a pool by means of a closed system. Sterility tests are made on the pool, a preservative is added, the serum is passed through a bacteria-excluding filter and distributed into the final containers through a closed system. Each lot of serum must be aged in the liquid state for at least 28 days at 2° to 10°C. subsequent to the removal of the clot and prior to its use as liquid serum, or prior to freezing and drying. Human serum complies with the requirements of the National Institute of Health of the U. S. Public Health Service.

**Description.**—Human Serum occurs in two forms, as liquid serum and dried serum. *Liquid serum*, when freshly collected, is a slightly opalescent liquid of a faint yellowish or amber color, and is practically odorless in the absence of a preservative producing an odor. A slight granular deposit or increased opalescence may develop on standing. *Dried serum* is made from liquid Normal Human



Serum, after aging for at least 28 days. It possesses a light yellow to cream color, and a honeycomb-like structure when examined under a microscope.

**Constituents.**—All of the liquid portion of the blood except fibrinogen.

**Storage.**—Liquid serum should be stored at a temperature between 2 and 10°C. The dried serum must not be exposed to excessive heat.

**Uses.**—In treatment of bacterial infections and to increase blood volume following hemorrhage.

**Average Dose.**—Intravenous, 500 cc.

CITRATED NORMAL HUMAN PLASMA U.S.P. (PLASMA HUMANUM  
NORMALE CITRATUM)

**Synonym.**—*Normal Human Plasma.*

**Definition.**—The sterile plasma obtained by pooling approximately equal amounts of the liquid portion of citrated whole blood from 8 or more humans (*Homo sapiens* L.) who have been certified by a qualified doctor of medicine as free from any disease which is transmissible by blood transfusion at the time of the drawing of the blood.

**Production.**—Each bleeding is drawn aseptically into individual, sterile centrifuge bottles already containing 50 cc. of a sterile, 4 per cent. solution of sodium citrate in isotonic solution of NaCl for each 500 cc. of whole blood. The cell-free plasma is separated by centrifuging, and transferred to a pool by means of a closed system. Sterility tests are then made, a preservative added, and the plasma is distributed into the final containers through a closed system. It must comply with the requirements of the National Institute of Health of the U.S. Public Health Service.

**Description.**—Citrated Human Plasma occurs in 3 official forms, viz.: (1) *Liquid plasma*, a faint yellowish or amber-colored, slightly opalescent liquid; (2) *Frozen plasma*, made from citrated normal human plasma, frozen quickly, within 72 hours of bleeding, and (3) *dried plasma*, made from frozen plasma without added dextrose by drying from the frozen state under vacuum.

**Constituents.**—All of the liquid portion of the blood including fibrinogen.

**Storage.**—Liquid plasma must be preserved at a temperature between 15° and 30°C.; Frozen plasma at a temperature of or under -15°C. Dried plasma must not be exposed to excessive heat.

**Uses.**—To replace plasma lost by hemorrhages, in anemias, malnutrition, infections, surgical shock, hypoproteinemia and severe burns.

**Average Dose.**—Intravenous, 500 cc.

**Plasma Fractions.**—In 1944, Cohn and his associates of Harvard isolated a number of the components or fractions of human plasma by the fractional precipitation of the protein constituents from alcohol-water systems of different pH values at low temperatures. Five fractions were obtained as well as a number of subfractions, viz.: fibrinogen, gamma-globulins, isohemaagglutinins, beta-globulins, prothrombin, thrombin, lipo-proteins and a fibrinolytic enzyme, alpha globulins, and albumin. A number of these and preparations thereof are now available.

**Gamma Globulins** are used in the treatment of measles and infectious hepatitis. **Prothrombin** is converted into **thrombin** by thromboplastin and used as a dry powder or in sterile isotonic salt solution, by topical application for the control of capillary bleeding. **Concentrated isohemaagglutinins** are employed in typing blood. **Fibrin Foam**, made by the interaction of fibrinogen and thrombin, is used in surgery to stop the flow of blood. **Fibrin Film**, appearing as thin rubbery sheets, is employed in brain surgery to replace the dura mater and to prevent adhesions after operations. **Dry Albumin** is employed in 25 per cent solution in the treatment of shock.

#### HUMAN IMMUNE GLOBULIN U.S.P. (GLOBULINUM IMMUNE HUMANUM)

**Synonyms.**—Placental Extract, Measles Prophylactic.

**Definition.**—A sterile solution of antibodies obtained from the placental blood and the placentae expelled by healthy women (*Homo sapiens* Linné). Each preparation shall be composed of a pool from at least ten individuals. It complies with the requirements of the National Institute of Health of the U. S. Public Health Service.

**Description.**—Human Immune Globulin occurs as a transparent or slightly opalescent liquid of a faint yellowish, greenish or brownish color and may possess a slight, granular deposit. It is nearly odorless or may have the odor of a preservative. It must be free from harmful substances detectable by inoculation into animals and must not contain an excessive proportion of preservative. It must be dispensed in the manufacturer's unopened container.

**Storage.**—It must be preserved at a temperature of between 2° and 10°C., preferably at the lower limit.

**Uses.**—In the prevention and modification of measles.

**Average Dose.**—Intramuscular. For modification, 2 to 8 cc. (30 to 75 minims). For prevention, 2 to 10 cc. (30 to 150 minims).

#### ORDER CETACEA

Aquatic mammals of fish-like form which for the greater part live in salt water. Posterior limbs and hairs are generally absent, although in some members (*whales*) rudiments of posterior limbs occur beneath the skin. The anterior limbs are paddle-like flippers. To this order belong the toothed or sperm whales which yield spermaceti, the toothless or baleen whales which yield whalebone and oil, the porpoises and the dolphins.

#### FAMILY PHYSETERIDÆ (SPERM WHALE FAMILY)

##### SPERMACETI U.S.P. (CETACEUM)

**Synonyms.**—Sperm Whale, Cachalot; *Ger.* Walrat; *Fr.* Céline.

**Zoological Origin.**—*Physeter macrocephalus* Linné.

**Part Used.**—A waxy substance obtained from the head of the sperm whale.

**Habitat.**—Atlantic, Pacific and Indian Oceans.

**Animal.**—A huge, toothed whale averaging 70 to 80 feet in length with a massive head, truncated in front and about one-third the length of the body.

On the upper surface of its skull occurs a large cavity containing fatty tissue from which sperm oil and spermaceti are obtained. The flippers are short and antero-lateral. On the dorsal surface there occurs a rudimentary dorsal fin as a low projection.

**Production.**—The sperm whale is killed by torpedo harpoons which explode within its body. A short time after the animal is killed, the fat cavity is opened and the oil collected in buckets. This, upon hardening, forms a yellowish mass which is placed in bags, drained and pressed to remove olein, purified by melting in hot water and skimming, boiled with weak alkaline solution, washed with water and allowed to harden.

**Description.**—It occurs in white, somewhat translucent, slightly unctuous masses, having a somewhat scaly-crystalline fracture, very faint odor and bland taste. It melts between  $42^{\circ}$  and  $50^{\circ}\text{C}$ . It is soluble in fixed and volatile oils, in boiling alcohol, and in chloroform and ether. On exposure to air it becomes yellow and rancid. The official drug must be free from rancidity.

**Constituents.**—*Cetyl palmitate* or *cetin* ( $\text{C}_{15}\text{H}_{31}.\text{COOC}_{16}\text{H}_{33}$ ) and small percentages of other fatty substances.

**Use.**—As a base for cerates and ointments.

**Preparation.**—Rose Water Ointment, U.S.P.

**Other Sperm Whale Products.**—*Ambergris* is a pathological product found in the intestine of sperm whales or cast by them into the sea. It occurs in irregular, waxy, grayish or brown masses or usually as gray masses with brownish yellow or white streaks. It contains ambrein and cholesterol. It is used as a fixative for delicate floral odors in perfumery.

**Sperm Oil** is a fixed oil obtained from the cranial cavity of the sperm whale, *Physeter macrocephalus* Linné (Fam. *Physeteridæ*). It is widely used as a lubricant for machinery, especially sewing machines.

#### ENDOCRINE GLAND PRODUCTS

The endocrine glands or glands of internal secretion of mammals, especially those obtained from cattle, sheep and swine and the isolated hormones of several of them have become established effective agents in modern organotherapy in the treatment of disorders in man due to insufficiency or absence of the endocrine glands or their internal secretions. It has been shown that there is an interrelationship between a number of these glands, and that an unbalanced condition of their secretions is a cause of many serious disturbances to health. Most of the endocrine glands are ductless and their hormones or active constituents pass directly into the blood or lymph to be carried to the organs and tissues, there to influence growth and development of the body and increase or decrease the functions of various of its organs. The more important of these gland products will be considered here.

#### THYROID U.S.P. (THYROIDEUM)

**Synonyms.**—Powdered Desiccated Thyroid, Thyroideum Siccum.

**Definition.**—The cleaned, dried and powdered thyroid gland previously deprived of connective tissue and fat. Obtained from domesticated food animals.

**Standard of Assay.**—Thyroid contains not less than 0.17 per cent. and not more than 0.23 per cent. of iodine in thyroid combination, and must be free from iodine in inorganic or any other form of combination other than that peculiar to the thyroid gland. A desiccated thyroid of a higher iodine content

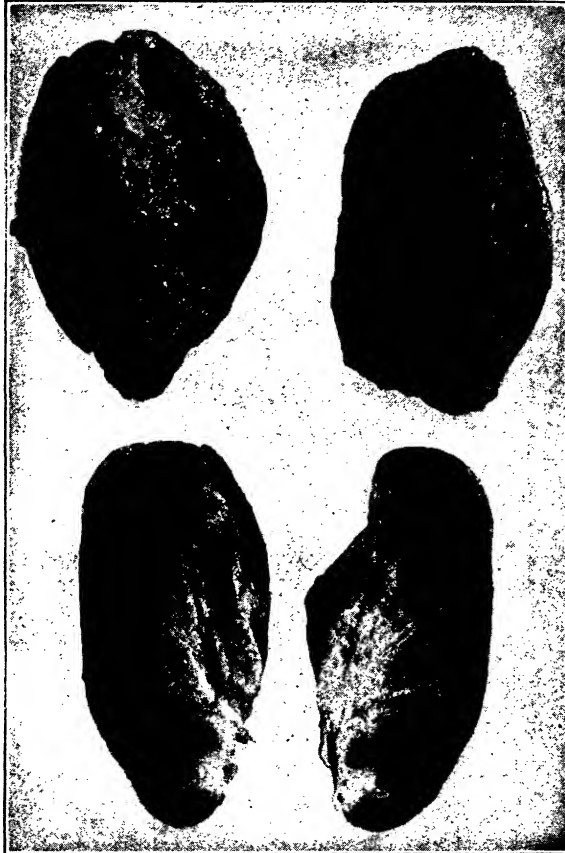


FIG. 500.—Thyroid glands of beef.  $\times \frac{4}{5}$ .

may be brought to this standard by admixture with a desiccated thyroid of a lower iodine content or with lactose or sodium chloride, starch or sucrose.

**Description of Gland.**—The thyroid is a ductless, compound tubular gland and consists of two large almond-shaped lateral lobes united by a narrow band, the middle lobe or isthmus, and forming a projection on the ventral surface of the trachea. The thyroid is surrounded by a capsule of dense white fibrous tissue that sends in trabeculae which divide the gland into lobes and lobules. The lobules are composed of a number of short, closed tubules or follicles. Each of these follicles is lined by cuboidal epithelial cells that rest upon a basement membrane. Outside of this is connective tissue which supports blood vessels and lymphatics. The lumen of each follicle contains colloidal material

or colloid which is formed by the epithelial cells. The colloid is thought to pass back into the follicular epithelial cells as required and from these into the capillaries or lymphatics which surround the follicles. The colloid is believed to contain the internal secretion or hormone.

**Preparation.**—The lobes of the thyroid are separately removed from the recently slain animal, deprived of enveloping connective tissue and fat, sliced

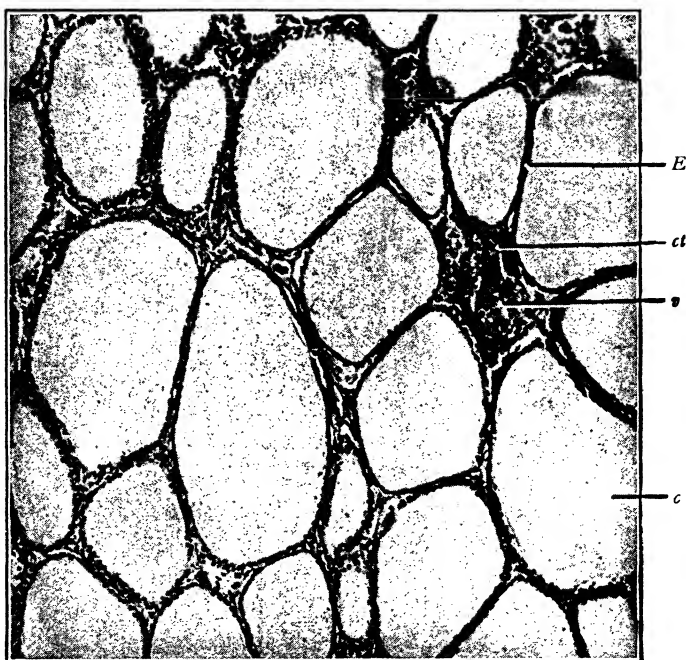


FIG. 501.—Transverse section through the parenchyma region of the thyroid gland of beef. *E*, cuboidal epithelium lining a follicle; *c*, colloid in a follicle; *ct*, connective tissue; *v*, blood vessel.  $\times 400$ .

or minced and rapidly dried in a current of warm air. They are then reduced to a coarse powder which is treated with petroleum ether for the partial removal of fatty matter present. The powder is then dried in a desiccator or in vacuum.

**Description of Drug.**—A yellowish to buff-colored amorphous powder having a slight characteristic, meat-like odor and a saline taste.

**Histological Characteristics.**—When suitably mounted and examined under the microscope, thyroid shows numerous smooth to striated hyaline fragments of colloid, of angular to irregular shape, which are colorless to pale yellow in water mounts, brown in Mallory's stain and pink in eosin solution, some of these fragments containing granules, minute vacuoles, crystalloidal bodies and cells; numerous irregular fragments of follicular epithelium staining brown with Mallory's stain, the individual cells more or less polygonal to rounded-angular or irregularly cuboidal, often with prominent nuclei staining dark blue, their

cytoplasm purplish with Delafield's hematoxylin T.S.; slender glistening segments of neuraxons; numerous aggregates of particles of intercellular substance and slender, mostly straight, connective tissue fibers staining blue to greenish blue with a mixture of Mallory's stain and 1 per cent. phosphotungstic acid; few glistening fragments of blood vessels with serrated or crenated ends as viewed in water mounts. Both the colloid and the follicular epithelium are also colored brown by a mixture of equal parts of Mallory's stain and 1 per cent. phosphotungstic acid solution.

**Constituents.**—*Thyroxin* ( $C_{15}H_{11}O_4NI_4$ ), the chief active constituent; mineral substances, a nucleo proteid, leucin, xanthin, choline, enzyme, lactic acid, etc. Thyroxin occurs in white, needle-shaped crystals which are odorless and tasteless, insoluble in water and alcohol but soluble in solutions of the alkali hydroxides and in hot solutions of alkali carbonates.

**Uses.**—In thyroid deficiency as in myxœdema or goitre, in the treatment of cretinism, to prevent adhesions in pleurisy, etc., in certain cases of obesity, etc.

**Average Dose.**—60 mg. (1 grain).

**Preparation.**—Thyroid Tablets (*Tabellæ Thyroidei*) U.S.P. (Usually available in  $\frac{1}{4}$ ,  $\frac{1}{2}$ , 1, and 2 grain amounts of thyroid.)

**Thyroxin or Thyroxinum U.S.P.** is an active physiological principle representing iodine in organic combination obtained from the thyroid gland or prepared synthetically. It contains not less than 64 per cent. of iodine as an integral part of the thyroxin molecule. Av. dose, 0.5 mg. ( $\frac{1}{120}$  grain).

#### SUPRARENAL N.F. (SUPRARENALUM)

**Synonyms.**—*Desiccated Suprarenal*, *Dried Adrenal Substance*, *Suprarenalum Siccum*, *Suprarenal Gland*.

**Definition.**—The dried, partially defatted and powdered suprarenal gland of cattle, sheep or hogs. It is derived from sound, clean and entire glands that are freed from external connective tissue and external fat.

**Purity Rubric.**—It yields not less than 0.8 per cent. of natural epinephrine of glandular origin, not more than 6 per cent. of moisture, and not more than 7 per cent. of total ash. One part of Suprarenal represents approximately 6 parts by weight of the fresh glands. It is free from diluents or preservatives. If dried by heat, it shall be dried in vacuum, and the temperature of the drying material shall not exceed 60°C.

**Description of the Whole Glands.**—The suprarenal or adrenal glands are more or less pyramidal shaped ductless glands, one being situated on the upper pole of each of the kidneys. Each gland is surrounded by a thin capsule of white fibrous connective tissue and presents for examination two regions, the cortex and medulla.

The *cortex* or outer firmer region is yellowish in appearance and when examined microscopically consists of a delicate framework of connective tissue in the meshes of which lie solid columns of epithelial cells. It is subdivided into three zones known in order from without inward as the *zona glomerulosa*, the

*zona fasciculata* and the *zona reticularis*. The cells of the *zona glomerulosa* are mostly large and polyhedral and contain many lipoid granules. In cross sections they appear in irregularly circular to oval groups. The columns of cells are



FIG. 502.—Suprarenal glands of beef (nat. size).

surrounded by a reticulum of connective tissue containing capillaries and nerve fibres. The *zona fasciculata* consists also of epithelial columns arranged in radial groups which are surrounded by connective tissue containing capillaries



FIG. 503.—Beef suprarenal split lengthwise through its center to show internal regions ( $\times \frac{4}{5}$ ).  
c, cortex; m, medulla.

and nerve fibres. The epithelial cells of this zone appeared to be larger than those of the cortical zones and contained lipoid granules. The *zona reticularis* is composed of a network of small polyhedral epithelial cells with large nuclei

and pigmented cytoplasm. It is the darkest tinted of the the three zones of the cortex.

The *medulla* comprises the central portion of the gland. It is soft in texture and brown in color. It consists of numerous polygonal to somewhat lobed and stellate, chromophil or chromaffin cells arranged in irregular groups and anastomosing cords that are surrounded by connective tissue containing blood vessels, blood sinuses, capillaries, nerve fibres and ganglion cells. The chromaffin cells

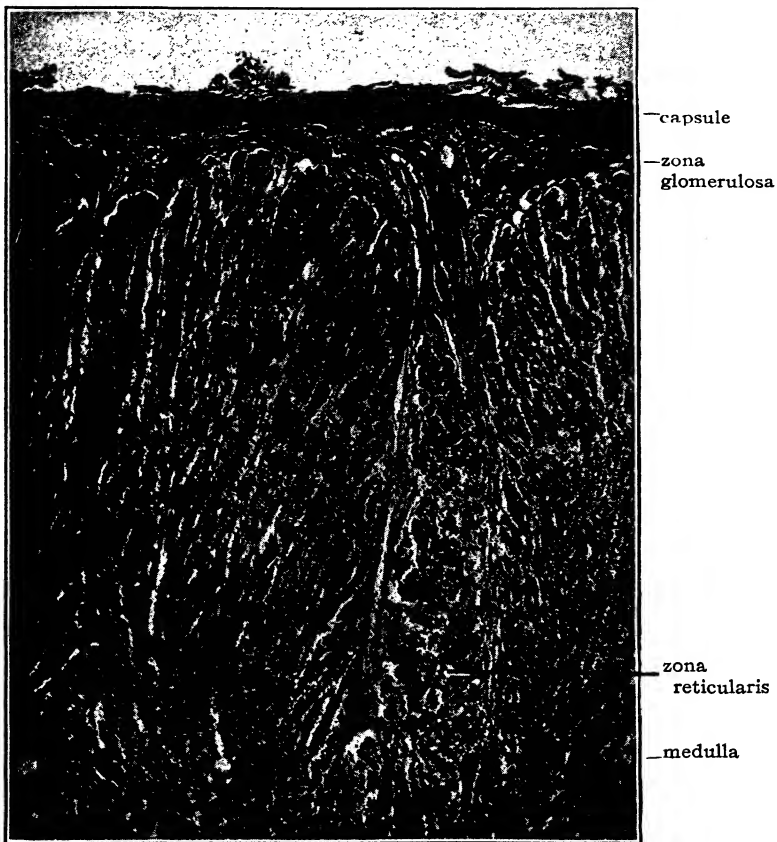


FIG. 504.—Suprarenal gland of beef. Photomicrograph of a transverse section of a representative part.

contain material which stains brown with solutions of chromic acid or its salts.

**Preparation.**—In the preparation of the powdered dessicated drug, the glands are obtained from freshly killed cattle, sheep and hogs, deprived of surrounding connective tissue and fat, sliced or minced and rapidly dried in a current of warm air. They are then reduced to a coarse powder, in some places partially defatted, and dried *in vacuo* at a temperature below 60°C. or by means of a dehydration solvent like acetone. It must be stored in tight containers and kept from excessive heat.



**Powdered Desiccated Suprarenal.**—The powder is amorphous, light yellow to brown, and possesses a slight characteristic odor. It is only partially soluble in water. No disagreeable odor suggestive of putrefaction is present.

Under the microscope the following histological elements were observed: Numerous chromaffin (chromophile) cells, both isolated and in loose aggregates, the individual cells stellate to irregular with spheroidal to oval nuclei and granular cytoplasm which takes a brownish coloration with chromic acid T.S.; numerous clear, jointed segments of non-medullated nerve fibres, the axons of which are colored mauve with hematoxylin and eosin T.S., numerous cortical cells both isolated and in masses, the individual cells cuboidal to irregularly rounded or rounded polyhedral, with spheroidal nuclei, some of the cells containing tiny fat globules, granules or pigment, the chromatin of the nucleus and granules staining blue and the protoplasm red to purple with Delafield's hematoxylin T.S. and alcoholic eosin; numerous fragments of connective tissue fibres, fibrocytes and particles of intercellular substance, the fibres wavy, the fibrocytes slender, linear to fusiform, and all colored blue with a mixture of Mallory's stain and a 1 per cent solution of phosphotungstic acid, numerous minute granules of crystalline appearance and irregular form and many isolated nuclei.

**Constituents.**—*Epinephrine (adrenalin)* ( $C_9H_{13}O_3N$ ) which occurs in the medulla of the gland; the cortical steroids *corticosterone*, *desoxycorticosterone* and *dehydrocorticosterone*; a yellowish brown pigment, etc.

**Uses.**—As a source of epinephrine and adrenal cortex extract, and orally in the treatment of Addison's disease.

**Average Dose.**—To be determined by the prescriber.

**Epinephrine U.S.P.** is lævo-methylaminoethanolatechol. It occurs as a white or pale brown, microcrystalline, odorless powder, gradually darkening on exposure to the air. Preserve in tight, light-resistant containers. Vasoconstrictor and hæmostatic. It is used in solution as a styptic in nose bleed, in solutions of procaine or cocaine used in minor surgery to prolong local anesthesia and prevent hemorrhage when such are injected; as a circulatory stimulant in collapse and shock, as a hæmostatic in postpartum hemorrhage and to check anaphylactic shock.

**Preparations.**—Epinephrine Solution (Liquor Epinephrinæ) U.S.P. (*Epinephrine Solution* 1:1000). This preparation is assayed on dogs. Epinephrine Injection U.S.P., subcutaneous or intramuscular, 1 mg. of epinephrine hydrochloride; Epinephrine Inhalation U.S.P. (*Epinephrine Solution* 1:100).

**Adrenal Cortex Extract N.N.R.** is an extract of suprarenal glands obtained from domesticated animals used as food by man which contains the cortical steroids essential for the maintenance of life in adrenalectomized animals. It influences electrolyte, water and carbohydrate metabolism. It is used in Addison's disease, other types of adrenal insufficiency, etc. It is standardized in dog units and administered by subcutaneous, intramuscular or intravenous injection. Dosage variable depending upon the degree of cortical insufficiency.

**Desoxycorticosterone Acetate U.S.P.** (*Deoxycosterone Acetate*) is an odorless, white crystalline powder produced from sarsapogenin and stigmasterol. It is

used in types of adrenal insufficiency affecting salt and water metabolism. Average dose.—Intramuscular and implantation—to be determined by the physician.

#### PARATHYROIDEUM (PARATHYROID)

**Synonyms.**—Parathyroid Gland, Glandula Parathyroidea.

**Definition.**—The parathyroid gland of the ox, *Bos taurus* (Fam. *Bovidae*) and other domesticated animals used for food by man, freed from gross fat and connective tissue.

**Description.**—The parathyroids are small oval fleshy ductless glands two of which are imbedded in the tissue of the dorsal surface of each lobe of the thyroid, one toward each extremity. In cattle there are, in addition to the four typical parathyroids, accessory parathyroids (external parathyroids) distributed in various parts of the neck.

The desiccated drug is a light yellow powder, having a peculiar odor. Its efficiency, when taken orally, is questionable.

**Dose.**—0.003 to 0.006 Gm. ( $\frac{1}{20}$  to  $\frac{1}{10}$  gr.).

**Parathyroid Injection (Injectio Parathyroidei)** *Parathyroid Solution* or *Parathyroid Extract* U.S.P. represents a sterile solution in water for injection of the water-soluble principle or principles of the parathyroid glands which have the property of relieving the symptoms of parathyroid tetany and of increasing the calcium content of the blood serum in man and other animals. The U.S.P. directs it to be obtained from the fresh parathyroid glands of healthy domesticated animals used for food by man. The parathyroid glands must be removed from the animals immediately after slaughtering and then extracted at once or kept frozen until extracted. The glands are freed from gross fat and connective tissue, ground, extracted, and the extract purified to make it suitable for parenteral administration. The injection is then adjusted to the proper potency by assay on mature male dogs.

One cc. of Parathyroid Injection possesses a potency equivalent to not less than 100 U.S.P. Parathyroid Units, each unit representing  $\frac{1}{100}$  of the amount required to raise the calcium level of 100 cc. of the blood serum of normal dogs 0.001 Gm. within 16 to 18 hours after administration. The animal source of each preparation must be stated on the label. It must be preserved in a cool place, preferably in single-dose, hermetically sealed or other suitable containers.

**Constituents.**—A hormone or complex protein derivative soluble in alcohol and acidulated water which withstands boiling for 2 hours and keeps for months on ice in the form of a watery solution.

**Uses.**—Parathyroid preparations are used to relieve the symptoms of parathyroid tetany and to increase the calcium content of the blood stream; in paralysis agitans, chorea, epilepsy, Grave's syndrome, certain thyroid affections, in the treatment of certain chronic ulcers; also with a calcium compound in conditions of abnormal calcium metabolism as in hay fever, asthma, etc.

**Average Dose of Parathyroid Injection.**—Intramuscular, 25 U.S.P. units (every 12 hours for 5 or 6 days, never more than 10 days in succession).

## WHOLE PITUITARY N.F. (PITUITARIUM TOTUM)

**Synonyms.**—*Pituitary Gland, Desiccated Pituitary Substance, Pituitary Body, Extract Pituitary Substance, Whole Desiccated Hypophysis, Glandula Pituitaria; Ger. Hypophyse; Fr. Poudre d'hypophyse entière.*

**Definition.**—Whole Pituitary consists of the dried, partially defatted and powdered pituitary glands of cattle, sheep, or swine. It is derived from sound, clean, and entire glands that are freed from external tissues.



FIG. 505.—Pituitary glands of beef,  $\times 1\frac{1}{4}$ . 1, convex surface to left; concave infundibular surface and side of gland to right. 2, lateral view of gland. 3, gland halved to show internal structure. a, anterior lobe; p, posterior lobe; i, infundibulum.

**Purity Rubric.**—It contains not more than 6 per cent. moisture, yields not more than 7 per cent. of total ash and not more than 5 per cent. of fat when extracted with petroleum benzin; and it is free from diluents and preservatives.

One part of whole pituitary is obtained from approximately 5 parts by weight of fresh pituitary gland, and when the fresh material is dried by heat,

it shall be dried in vacuum, and the temperature of the drying material shall not exceed 60°C.

**Description of Fresh Gland.**—The Pituitary Body or Hypophysis cerebri is a small somewhat ovoid body found within the skull of vertebrates and is firmly lodged in a depression known as the sella turcica of the sphenoid bone. It is encased by a fibrous capsule of connective tissue representing chiefly dura mater which lines the cranium. It consists of an anterior lobe, a small posterior lobe and a pars intermedia.

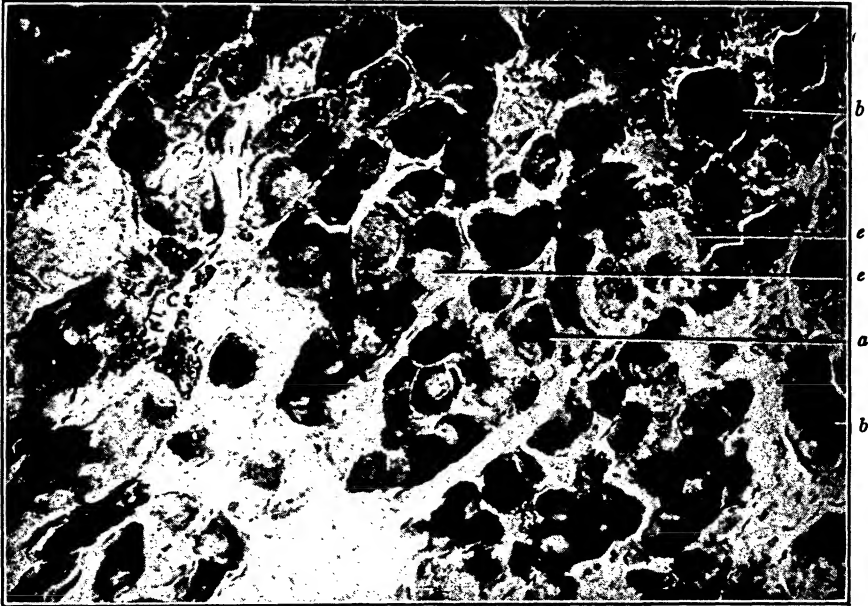


FIG. 506.—Anterior Pituitary of Beef. Sagittal section stained by the copper-hematoxylin method followed by treatment with Weigert's differentiator. *a*, chromophile cells with alpha granules; *b*, chromophile cells with beta granules; *c*, chromophobe cells; *c*, capillary.  $\times 400$ .

The anterior lobe is hollowed behind so as to form a concavity for the lodgement of the posterior lobe. The anterior lobe is epithelial in origin and represents an offshoot from the primitive mouth cavity of the embryo. The posterior lobe is neural in origin, being derived from the brain, and is connected with the brain by the infundibulum. The pars intermedia which is fused with the posterior lobe where it abuts with the anterior lobe represents an upward growth of the posterior buccal pouch.

Whole beef pituitaries are 2 to 2.3 cm. in length, 1.5 to 1.8 cm. in width and 1 to 1.5 cm. in vertical height. They possess a circular to lens-shaped scar on one surface marking the place of severance from the infundibulum and are enveloped (except at scar) by tough, fibrous meningeal tissues. In median longitudinal sections each shows a large reddish-gray anterior lobe separated by a cleft from a small yellowish-gray pars intermedia adherent to a light gray posterior lobe.

**Histology.**—Thin celloidin sections cut in sagittal and horizontal planes, when stained with hematoxylin and eosin solution, show the following structure:

Covering the entire gland is a capsule of fibrous tissue composed for the greater part of wavy fibers and separating the two lobes from each other is a bluish stained fibrous lamella of connective tissue, the posterior lobe being the smaller and partly surrounded (in the median horizontal section) by the anterior or larger lobe into which it fits.

**Anterior Lobe.**—The anterior lobe consists largely of parenchyma composed of a number of solid, branched, irregular epithelial cords, the branches forming numerous anastomoses. Between these cords occur broad capillaries coursing through connective tissue which encircles each cord or alveolus. The cells of the epithelial cords vary in their staining capacity as well as their internal structure. While several types may be found, two varieties, the chromophobe and chromophile cells, are the most outstanding.

The chromophobe or chief cells have a light staining capacity, are of cubical to low columnar form and with or without distinct cytoplasmic granules. Their nuclei are often stained like the cytoplasm. The chromophile cells are larger than the former type, have a heavier staining capacity, are of polyhedral form and possess large cytoplasmic granules and nuclei stained deep blue. Some of both of these types are *basophilic* and so their cytoplasm takes the blue to purple stain of hematoxylin, others are *acidophilic* and their cytoplasm takes the eosin or red stain. Pink stained eosinophilic (acidophilic) cells occur adjacent to the blood vessels along the epithelial cords. Both kinds of cells may contain lipid droplets and droplets of secretion.

Here and there in the section, the cell cords become hollowed out to form follicles which may contain colloidal material. The colloidal material may be hyaline or granular and is usually stained pink or orange.

**Posterior Lobe.**—This presents for examination (*a*) an outer zone of irregular endymal cells (excepting where the two lobes are in contact), and (*b*) the mossy neuroglia cells making up most of the tissue within, (*c*) a few scattered nerve fibers, (*d*) large ovoid or spindle-shaped multipolar cells or pituicytes which may or may not contain pigment, and (*e*) flask-shaped cells with short axones. Here and there areas containing pink or orange stained colloidal material may be discerned. Some of the nerve fibers may be observed extending to colloidal or hyaline material.

The *pars intermedia* or intermediate lobe is attached like a band to the front of the posterior lobe and sends trabeculæ into the latter. In it will be noted the polyhedral cells with blue stained nuclei and pink to lavender, granular cytoplasm as well as broad capillaries with pink stained contents. The epithelial cell cords or alveoli are not completely surrounded by connective tissue.

**Copper-hematoxylin Method.**—When the celloidin or paraffine sections are first treated with copper acetate solution as a mordant and then stained with Weigert's hematoxylin, then with eosin solution and followed by treatment with Weigert's potassium ferricyanide and borax differentiator, the

different types of epithelial cells in the pituitary can be excellently differentiated. By this method the chromophobe cells show a clear, pink cytoplasm devoid of stained granules and the chromophile cells are seen to be of two types, (a) *chromophile cells* containing *alpha granules* and (b) *chromophile cells* containing *beta granules*. The alpha granule-containing cells show a blue-stained nucleus and a cytoplasm possessing distinct, small, rounded, blue-stained bodies whilst the beta granule-containing cells show a similar nucleus with much finer, less distinct granules which form a bluish rather homogeneous mass. Lipoid granules occur in both chromophobe and chromophile cells which stain black with osmic acid solution. These should not be confused with the blue granules heretofore described. A number of small, scattered groups of small rounded cells with blue stained nucleus and cytoplasm and which may be regarded as *basophiles* occur in the anterior lobe, pars intermedia and, due to invasion, may be seen in some sections through the posterior lobe.

**Powdered Desiccated Whole Pituitary.**—This occurs as a gray to yellowish gray amorphous powder with a characteristic odor and a saline and disagreeable taste.

The microscopical elements are as follows: Numerous yellowish masses of polyhedral cells surrounded in parts by connective tissue, the latter staining blue with a mixture of Mallory's stain and 1 per cent. phosphotungstic acid solution; numerous large, polyhedral chromophile cells with central rounded nuclei and coarse cytoplasmic granules staining red with acid fuchsin, the nuclei colored blue and the cytoplasm reddish purple with eosin and methylene blue solution; numerous altered, cubical to low columnar chromophobe cells, with or without distinct cytoplasmic granules, whose nuclei are stained light blue and cytoplasm paler blue with eosin and methylene blue, both chromophile and chromophobe cells frequently with minute fat droplets colored brown to black with 1 per cent. osmic acid solution; few cells containing a colloidal substance and fragments of colloid appearing pale greenish to colorless in water mounts and staining brown with Mallory's stain; few segments of blood vessels of tubular, hyaline nature, the cut ends of which show serrated dark outlines when examined in silver nitrate solution; numerous mossy neuroglia fragments, the cells with spherical nuclei and elongated, branching processes staining black with 1 per cent. silver nitrate; a few small, faintly basophilic, polyhedral cells from the pars intermedia with pale blue nuclei and a pink, granular cytoplasm when stained with hematoxylin and eosin; a number of angular hyaline colloid fragments; fragments of nerve fibers with or without a bulbous end, the axons of which are colored mauve with eosin and hematoxylin; a few cells colored black with osmic acid solution; a number of spindle-shaped, bipolar nerve cells. See also pp. 1005 and 1006.

**Constituents.**—*Prolan A and Prolan B* (sexual hormone regulators), a hormone influencing metabolism, an oxytocic principle called *alpha-hypophamine* (*oxytocin* or *pilocin*); a pressor-antidiuretic principle called *beta-hypophamine* (*vasopressin* or *pitressin*); proteins, lipid, cholesterin and extractive. Analyses of the oxytocic and pressor principles show them to be polypeptides.

**Uses.**—In pituitary dysfunction or hypopituitarism.

**Average Dose.**—To be determined by the physician.

#### ANTERIOR PITUITARY N.F. (PITUITARIUM ANTERIUS)

**Synonyms.**—*Pituitary Anterior Lobe, Pituitary Body Anterior Lobe, Desiccated Pituitary Anterior Lobe, Extract of Pituitary Anterior Lobe, Desiccated Anterior Pituitary.*

**Definition.**—The dried, partially defatted and powdered anterior lobe of the pituitary gland of cattle, sheep or swine.

**Purity Rubric.**—Anterior Pituitary is derived from sound, clean and entire glands that are freed from external tissues. It contains not more than 6 per cent. of moisture, yields not more than 7 per cent. of total ash and not more than 5 per cent. of fat when extracted with petroleum benzin, and is free from diluents and preservatives.

One part of Anterior Pituitary represents approximately 5 parts by weight of fresh anterior lobe of the pituitary gland, and, when the fresh material is dried by heat, it shall be dried in vacuum and the temperature of the drying material shall not exceed 60°C.

**Description.**—This occurs as a gray or yellowish gray amorphous powder with a characteristic odor and saline taste. It is partially soluble in alcohol, ether, water and acetone.

The histological elements are as follows: Numerous yellowish masses of polyhedral cells surrounded in parts by connective tissue, the latter staining blue with a mixture of Mallory's stain and 1 per cent. phosphotungstic acid solution; numerous large polyhedral chromophile cells with central rounded nuclei and coarse cytoplasmic granules staining red with acid fuchsin T.S., the nuclei colored blue and the cytoplasm red-purple with eosin and methylene blue solution; numerous cubical to low columnar chromophobe cells with or without distinct cytoplasmic granules whose nuclei are stained light blue and cytoplasm paler blue with eosin and methylene blue, both chromophile and chromophobe cells frequently with fat droplets colored brown to black with 1 per cent. osmic acid solution; colloidal material occurring between certain of these cells appearing greenish in water mounts; a few scattered cylindrical nerve fibers often attached to fragments of blood vessels, appearing hyaline in water mounts, their axis cylinders staining a delicate purple color with eosin and hematoxylin solution; few segments of blood vessels with cut ends showing crenate inner endothelial margins and best seen in silver nitrate solution; a few spheroidal cells with reddish brown lipid content colored black with 1 per cent. osmic acid solution; a few fragments of colloidal substance of colorless or pale greenish aspect in water mounts. See also pp. 1005 and 1006.

**Constituents.**—The sexual hormone regulators *Prolan A* (folliculotropic hormone) and *Prolan B* (luteinizing hormone), a *prolactin* (lactosecretory hormone) which is stated to initiate and maintain milk secretion, *thyrotropic hormone*, necessary for the normal development and function of the thyroid, a *growth hormone* responsible for the development of the body, a *diabetogenic*

*hormone* which lessens the blood-sugar-reducing effect of insulin injections, proteins, lipoids including cholesterin, and extractive. Prolan A is a follicle stimulating hormone, inducing the formation of Graafian follicles and activating them to secrete *estradiol*. Prolan B acts on the Graafian follicle after ovulation and causes it to form corpus luteum.

**Uses.**—As an ovarian activator and regulator of menstruation, in atrophy of the anterior lobe, in menopause symptoms, hypogenitalism, etc.

**Average Dose.**—To be determined by the physician.

#### POSTERIOR PITUITARY U.S.P. (PITUITARIUM POSTERIUS)

**Synonyms.**—Pituitary, Desiccated Posterior Pituitary, Hypophysis Sicca, Pituitarium U.S.P. X.

**Definition.**—The cleaned, dried and powdered posterior lobe obtained from the pituitary body of domesticated animals which are used for food by man.

The pituitary must be removed from the animal immediately after slaughtering and then dried at once or kept frozen until dried.

**Standard of Assay.**—The potency shall be such that 1 mg., when assayed by the U.S.P. method, shall possess an activity equivalent to not less than 1 U.S.P. Posterior Pituitary Unit.

**Description.**—Powdered Desiccated Posterior Pituitary occurs as a yellowish or grayish amorphous powder with a characteristic odor and a saline, disagreeable taste. It is partially soluble in water, alcohol, ether and chloroform.

The following histological elements have been detected:

Numerous fragments of neuroglia tissue (mossy neuroglia) with spheroidal nuclei and long, slender, branching processes best distinguished with 1 per cent. phosphotungstic acid and hematoxylin which stains the nuclei blue and the processes bluish black; numerous spindle-shaped bipolar nerve cells; a number of ovoid, multipolar nerve cells whose cell bodies sometimes contain pigment granules and whose several processes appear bluish black in phosphotungstic acid and hematoxylin mounts; fragments of nerve fibers with or without a bulbous end, some of the bulbous ends of which are surrounded by cells containing a greenish yellow colloidal substance; the axons of the nerve fibers colored mauve with eosin and hematoxylin solution; a few amyloid bodies of ovoid or crescent shape staining a deep purple with iodine water; polyhedral cells and colloid vesicles from the pars intermedia; many irregular hyaline fragments. See also pp. 1005 and 1006.

**Constituents.**—Two principles soluble in water, viz., *oxytocin* (pitocin), an oxytotic substance and *pitressin* (vasopressin), a pressor, antidiuretic and gastrointestinal stimulant substance, a melanophore principle, etc.

**Uses.**—In uterine inertia, intestinal stasis following operations, urine retention, in menstrual headache, menorrhagia, metrorrhagia, in shock, pyelitis, herpes zoster, as an anti-diuretic in nocturnal incontinence of urine, in shingles (in the form of the official injection), and in diabetes insipidus.

**Average Dose.**—(Unofficial dose) 0.03 Gm. ( $\frac{1}{2}$  grain).

**Preparations.**—Posterior Pituitary Injection, U.S.P. (This is made from fresh posterior lobe.) By intramuscular or subcutaneous injection, in obstetrical



cases (5 to 15 minims); in surgical cases (15 to 30 minims). Av. dose, Intramuscular, 1 cc.

*Injectio Pituitarii Posterioris U.S.P.* or *Posterior Pituitary Solution* is a sterile solution in water of injection of the water-soluble principle or principles from the posterior lobe of the pituitary body of healthy domesticated animals used for food by man. One-tenth cc. of this injection, when assayed by the U.S.P. method, must possess an activity equivalent to one U.S.P. Posterior Pituitary Unit.

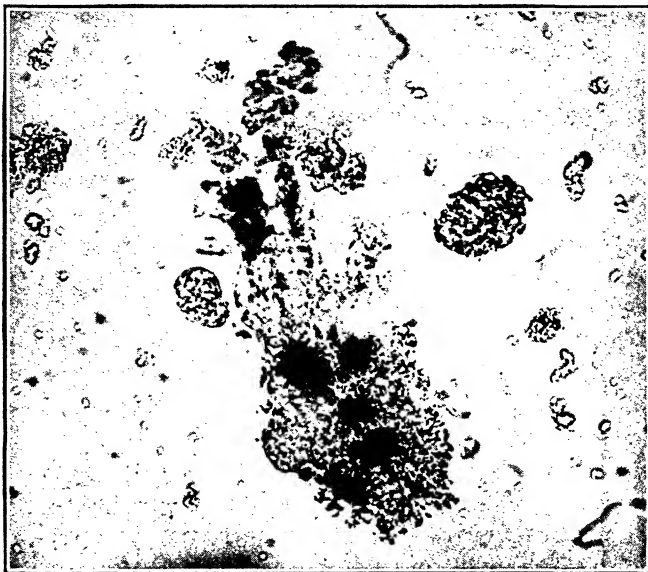


FIG. 507.—Fragments of the powdered desiccated pituitary showing glial cells as the black objects. Preparation made by a modification of the Penfield-Hortega method.  $\times 400$ .

The N.N.R. recognizes Ampuls of Pitocin and Ampuls of Pitressin. **Ampuls Pitocin** represents a sterile aqueous solution of the oxytocic principle (*alpha-hypophamine*) of the posterior pituitary which is used in obstetrics by intramuscular injection to stimulate uterine contractions, especially in cases where increase in blood pressure is undesired. Dose, 5 to 15 minims.

**Ampuls Pitressin** is a sterile aqueous solution containing the pressor and diuretic-antidiuretic principle (*beta-hypophamine*) of the posterior pituitary. It is used intramuscularly for raising blood pressure, for its antidiuretic action in diabetes insipidus and for increasing the muscular activity of the bladder and intestine. Dose, intramuscular, 5 to 15 minims.

#### OVARY N.F. (OVARIVM)

**Synonyms.**—*Ovarium Siccum*, *Desiccated Ovarian Substance*, Powdered Desiccated Ovary.

**Definition.**—The dried, undefatted and powdered ovary of cattle, sheep and swine.

**Purity Rubric.**—Ovary is derived from sound, clean and entire glands that are freed from external connective tissues and external fat, and yields not more than 6 per cent. of moisture and not more than 7 per cent. of total ash. It is free from diluents and preservatives.

One part of ovary represents approximately 6 parts by weight of fresh glands. It must be dried in vacuum and the temperature of the drying material must not exceed 60°C.

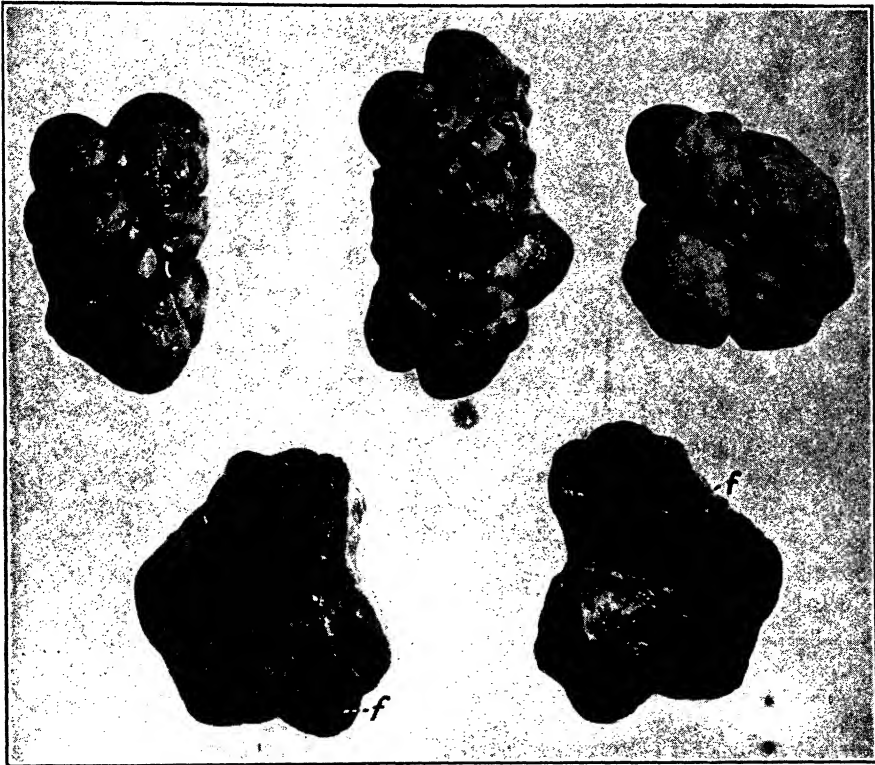


FIG. 508.—Ovaries of Pig showing mulberry-like appearance due to projecting Graafian follicles. Upper row, whole ovaries. Lower row, an ovary cut lengthwise showing the positions of the follicles within the gland (nat. size).

**Description of Fresh Ovaries.**—The ovaries or female sexual glands are small, solid organs of oval outline situated slightly above the middle of the lateral margin of the pelvic inlet in the non-pregnant animal and variable in animals that have borne young. Those of the cow are from 3 to 5 cm. in length and up to about 2 cm. in thickness. The ovaries of the sow are concealed in the *bursa ovarii*. The exterior of the glands have a mulberry-like appearance. The greater portion of the surface of the ovary is covered with germinal epithelium. When an ovary is bisected and the cut surface examined with a lens, it will be noted that a peripheral interrupted ring of small follicles containing young ova lie beneath the germinal epithelium covering interrupted by mature

follicles. These are imbedded in a framework of connective tissue called the ovarian stroma which extends throughout the whole interior. Farther inward occur follicles containing ova in varying stages of maturity. Upon the bursting of a follicle the ovum and contained fluid are liberated and the follicle fills with an orange or yellow body called the "*corpus luteum*."

**Histology.**—Suitably imbedded, stained and mounted cross sections cut through the ovary present for examination the following regions:

1. The *cortex* or outer zone covered by a layer of *germinal epithelial* cells of cuboidal or low columnar character beneath which occurs a very cellular connective tissue *stroma* in which are imbedded *follicles* in various stages of development. The tissue directly beneath the germinal epithelium is called the *tunica albuginea*; just beneath it will be noted some thin-walled lymphatic vessels.

2. The *medulla* or central zone of less cellular and loose connective tissue containing many blood vessels and nerve fibers. Some of the larger follicles extend into the medulla. This region shows abundant elastic fibers and strands of smooth muscles surrounding the blood vessels and nerve fibers. The nerve fibers are chiefly non-medullated and run to the blood vessels.

The *follicles* are found chiefly in the outer zone. They are composed of *oöcytes* and their surrounding cells. The larger ones contain an egg or *ovum*, containing a nucleus within which is a nucleolus, the nucleus surrounded successively by *granular yolk*, *cytoplasm*, a *zona pellucida*, and finally by several rows of radially arranged cells called the *corona radiata*.

The smaller follicles will be found in the outermost region of the cortex and contain *oöcytes*. The *primary follicles* should be found just beneath the *tunica albuginea*. Each is composed of an *oöcyte* or undeveloped egg of spherical shape surrounded by a layer of flattened cells called follicle cells. All stages will be found between these and the largest *Graafian follicles*, some of which may have been pressed outward, discharged their eggs, rupturing the germinal epithelium.

The larger follicles contain follicle cells which have become more numerous and have crowded each other into cuboidal and columnar shapes forming a stratified epithelial layer. A cavity in some of the follicles is surrounded by the *stratum granulosum* (granular stratified epithelium) and the *oöcyte* is on one side of the follicle. In larger follicles the surrounding connective tissue stroma is moulded into a sheath called the *theca follicula*. The larger follicles containing cavities are called *Graafian follicles* or *vesicular follicles*. Some of them may contain more than one *oöcyte*.

The *theca folliculi* in older follicles is differentiated into an inner vascular region of fibers, cells rich in cytoplasm and blood vessels called the *tunica interna*, and an outer fibrous region called the *tunica externa*.

**Powdered Desiccated Whole Ovary.**—This product occurs as a pale buff to yellowish brown, amorphous powder, the predominance of yellow or brown in the color combination depending upon the ratio of corpus luteum to other ovarian substance, the species of the animal yielding the product and the period

at which the ovaries were removed from the animal. It possesses an odor resembling ground mash and a salty, disagreeable taste. It is slightly soluble in water, alcohol, ether and petroleic ether.

The following histological elements occur:

Numerous young, unicellular follicles and fragments of older Graafian follicles, usually somewhat altered, the young follicles appearing as spherical to oval-shaped bodies containing a central cell or oöcyte which is colored deep blue with Heidenhain's hematoxylin and alum solution; surrounding the oöcyte in older follicles occurs a single layer of flattened follicular cells resembling the germinal epithelial cells whose nuclei are stained deep blue with Delafield's or Heidenhain's hematoxylin, while attached to parts of the follicle is a small amount of connective tissue which is colored pink with eosin solution and blue with a mixture of Mallory's stain and 1 per cent. phosphotungstic acid test solution; a few more or less distorted cubical to low columnar and transitional germinal epithelial cells, occurring singly or in groups, with a round central nucleus and granular cytoplasm, the granules glistening in water mounts, the nucleus staining a deep blue with Delafield's hematoxylin T.S., a number of small, compact masses of dense, white fibrous connective tissue consisting of white collagenous fibers and fibrocytes, the fibers appearing long, narrow, transparent and wavy (in coarsely ground material), with distinct pointed ends, difficult to discern in water mounts, but swelling and visible in a mixture of 1 per cent. acetic acid and ss. picric acid, and staining a brilliant red in acid fuchsin, the bundles of fibers showing numerous fibrillæ which exhibit a dark outline when mounted in 3 per cent. aqueous solution of silver nitrate, the fibrocytes appearing irregularly polygonal to slightly elongated, usually forked at one end in surface view and spindle-shaped in profile view, the nuclei staining a deep blue and the cytoplasm a pale blue to purplish blue with Delafield's hematoxylin T.S.; few scattered spindle-shaped, smooth muscle fibers with centrally placed nucleus clearly visible in gold chloride T. S.; few capillaries of tubular, hyaline nature, occasionally branched and grayish to grayish black in outline with 1 per cent. silver nitrate solution; fragments of larger blood vessels with circular to oval cut ends, their endothelial layer at ends being serrated and taking a pink color with eosin and hematoxylin; occasional large spherical cells containing globules of lipoid substance which stains black with 1 per cent. osmic acid solution; scattered segments of non-medullated nerve fibers of cylindrical form and consisting of neuraxon and neurilemma, the neuraxon taking a blue color with Delafield's hematoxylin T.S., a mauve color with hematoxylin and eosin solution and a deep red with acid fuchsin; numerous interstitial cells of rounded to ovate form, some of them slightly beaked, containing granules and shining fat globules, their nuclei staining a deep blue and their cytoplasm a pink color with hematoxylin and eosin; numerous lutein cells appearing yellow in water mounts; when the material contains corpora lutea, the cells large, polyhedral to oval, often in masses, each containing a central nucleus, lutein granules and fat droplets.

**Constituents.**—The primary estrogen called *alpha-estradiol*, also called *estradiol* and *follicular hormone* ( $C_{18}H_{24}O_2$ ); *progesterone* or *progestin* ( $C_{21}H_{30}O_2$ ), pregnandiol, cholesterin, etc. Within the body alpha-estradiol or dihydroxy-estrin is broken down to *estrone* or *theelin* (ketohydroxyestrin) and *estriol* (theelol or trihydroxyestrin) which compounds are excreted in the urine. Theelin, also called female sex hormone, estrin and folliculin, has been isolated from the urine of pregnant females in crystalline form by Doisy in 1930. Progesterone, the

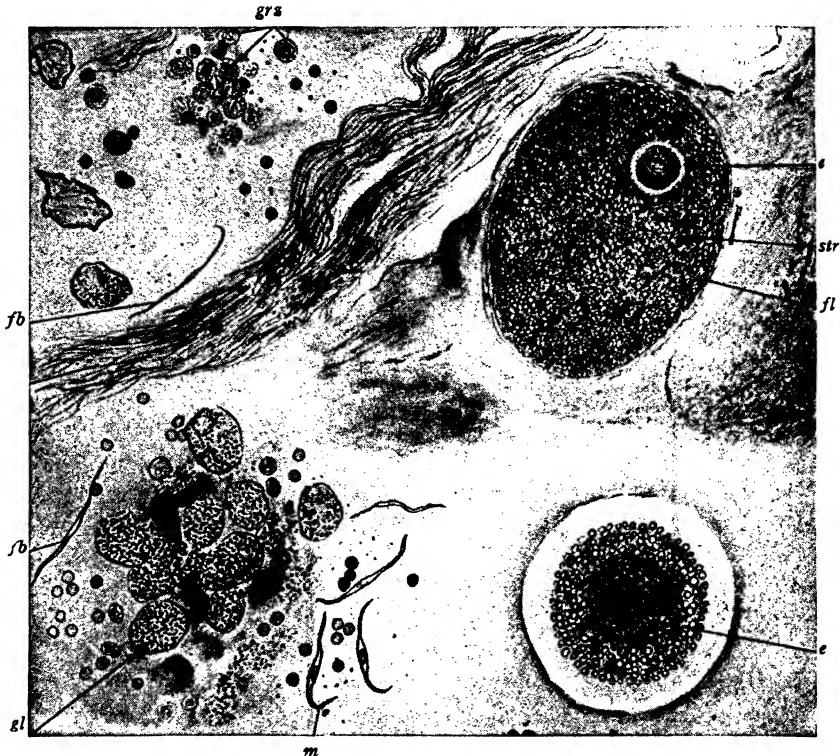


FIG. 509.—Teased-out preparation of the fresh pig ovary. *e* (below, on right), ovum showing the zona pellucida as the light area, also the yolk nucleus and cell granules; *b*, connective tissue fibers and fibrocytes; *grs*, cell from the stratum granulosum and theca folliculi of the follicle; *fb*, fibroblasts; *m*, smooth muscle fibers; *gl*, granulosa cells from the corpus luteum.  $\times$  about 400. *fl*, Graafian follicle  $\times 60$  to  $70$ ; *e*, egg cell; *str*, stratum granulosum. (From Wasicky's *Leitfaden f.d. Pharmacog. Untersuch.*)

corpus luteum hormone, was isolated by Wintersteiner and Allen in 1934.

**Uses.**—In ovarian dysfunction including nervous disorders and hot flushes at menopause. Alpha-estradiol stimulates the growth and development of the myometrium or muscular tissue of the uterus and the mucous membrane lining of the uterus or endometrium. It also stimulates the development of the mammary duct system, the development of secondary sex characteristics and controls the rhythmic contraction of the uterus. It acts as a brake on the

anterior pituitary. Theelin stimulates proliferation and growth of the uterine endometrium. It is used in secondary amenorrhea and oligomenorrhea, genital hypoplasia, functional sterility and to overcome the nervous symptoms at menopause. Preparations of the ovary as well as of the placenta are sometimes used as galactagogues.

**Average Dose.**—To be determined by the prescriber.

#### OVARIAN RESIDUE N.F. (RESIDUUM OVARI)

**Synonym.**—*Desiccated Ovarian Residue*, Powdered Desiccated Ovarian Residue.

**Definition.**—The dried, undefatted and powdered ovary without the corpus luteum from cattle, sheep and swine.

**Purity Rubric.**—Ovarian Residue is derived from sound, clean glands, freed from external connective tissue and external fat and, as far as practicable, from corpus luteum material. It contains not more than 6 per cent. of moisture and yields not more than 7 per cent. of total ash. It is free from diluents or preservatives.

One part represents approximately 6 parts by weight of fresh ovary without the corpus luteum. It should be dried in vacuum. The temperature of the drying material shall not exceed 60°C.

**Desiccated Ovarian Residue.**—This represents the whole ovary from which the corpus luteum has been separated by means of a scalpel, ground, dried, powdered and sifted. But the perfect separation of corpus luteum is not always carried out in practice.

The powder, therefore, contains the same elements as that of powdered, desiccated whole ovary but only very few or no lutein cells. It contains a relatively larger amount of connective tissue than ovary. It is a yellow or brown powder only partly soluble in water with a characteristic odor.

**Constituents.**—The steroid hormones *alpha-estradiol*, *estrone* and *estriol*; cholesterin, fat, etc.

**Uses.**—In conditions of hypofunction and dysfunction of the ovaries, in nervous manifestations of the climacteric, etc.

**Average Dose.**—To be determined by the prescriber.

#### ESTROGENIC HORMONES (ESTROGENS)

Estrogenic hormones are steroids, a class of compounds which has a wide distribution in nature among animals and plants. The most important of these are *alpha-estradiol*, *estrone* and *estriol*.

**Estradiol U.S.P. or Alpha-estradiol**, the primary estrogenic hormone, also known as dihydroxyestrin, *dihydroxytheelin* and progynon DH, is found in the ovary of mammals. It is obtained from the follicular fluid of the hog and mare pregnancy urine and may be synthesized from estrone and ergosterol. Prolan A, or the follicle stimulating hormone of the anterior pituitary, induces the growth of the Graafian follicles, the theca interna of which is believed to secrete estradiol in the follicular fluid. The hormone passes into the circulation and

induces changes in the body associated with the development of the female sex characteristics. During the menstrual cycle it stimulates the proliferation of the endometrium or lining membrane of the uterus and the cornification of the vaginal mucosa.

This drug is the most potent of the estrogenic hormones. It is rapidly absorbed and acts immediately. It is administered orally and locally in the form of tablets, solution, ointment, suppositories and nasal spray; in uterine hypoplasia, hypoplastic dysmenorrhea, hypogonadal sterility, juvenile and senile vaginitis, vaginal atrophy, breast hypoplasia, pruritus or kraurosis vulvæ, atrophic rhinitis, and various other disturbances due to estrogenic deficiency.

**Average Dose.**—0.2 mg. ( $\frac{1}{300}$  gr.). **Preparation.**—Tablets.

In order that the effects of estradiol may be prolonged various esters of it have been prepared, the most active of which is stated to be the benzoate. This has occurred on the market in trade preparations, as Progynon B, Dimenofomron Benzoate, Ben-Ovocyclin, etc.

**Estradiol Benzoate (Estradiolis Benzoas) U.S.P.** *Æstradiol Monobenzoate*  $C_{25}H_{28}O_3$ . It occurs as a white or pale yellow or brown, odorless, crystalline powder almost insoluble in water, but soluble in alcohol, dioxane and acetone and sparingly soluble in vegetable oils. Av. dose, Intramuscular 1 mg. ( $\frac{1}{60}$  grain). Intramuscularly, in oil. **Preparation.**—Injection.

**Estrone (Estronum) U.S.P.**  $C_{18}H_{22}O_2$ . Synonyms: Ketohydroxyestrin, *Æstrone*, *Theelin*. Estrone is a crystalline estrogenic steroid (3-hydroxy 17-keto-1,3,5(10)-estratriene, obtained from the urine of pregnant animals. It occurs as white crystals or a white, crystalline powder. It is odorless, slightly soluble in water, but quite soluble in alcohol and dioxane. It is used in the treatment of symptoms of menopause, senile and juvenile vaginitis, pruritus vulvæ and kraurosis vulvæ. It is effective by mouth, but is usually administered in the form of a sterile solution of the hormone in sesame, cottonseed or peanut oil by intramuscular injection or in suppositories. Av. dose, 1 mg. ( $\frac{1}{60}$  grain).

**Estriol N.N.R.** (Theelol)  $C_{18}H_{24}O_3$ . 3,16,17-trihydroxy-1,3,5-estratriene. Estriol is a crystalline estrogenic steroid obtained from pregnancy urine and human placenta and produced synthetically from cholesterol and other sterols. Like estrone it is formed in the body from estradiol and excreted in the urine as a waste product. It occurs as a white, odorless, microcrystalline powder which exhibits a reddish fluorescence under filtered ultraviolet light. It is insoluble in water, but soluble in alcohol, dioxane and oils. It is administered orally in capsules, pulvules or kapseals in doses of 0.06 to 0.12 mg.

Both estrone and estriol stimulate proliferation of the endometrium of the uterus, increase the rhythmic contractility of the uterus, inhibit the activity of the pituitary, change the vaginal secretion from alkaline to acid, and stimulate growth of the immature and senile vaginal epithelium to the adult type as found in estrus.

**Allied Drug.—Diethylstilbestrol U.S.P.** (alphadiethyl-4:4'-stilbenediol), a synthetic or artificial estrogen, occurs as a white, odorless, crystalline powder soluble in alcohol, fatty oils, etc. Its physiological action is similar to the

natural estrogens, estrone and estriol, but it is apparently more toxic than these, having produced nausea and vomiting and other gastrointestinal disturbances in some patients. It is used in the treatment of menopausal syndrome, suppression of lactation, in senile and gonorrheal vaginitis, etc. It is claimed to be more effective orally than estrone and estriol and to possess a more prolonged action. Av. dose, 0.5 mg. ( $\frac{1}{20}$  gr.). U.S.P. Preparations.—Diethylstilbestrol Capsules, Diethylstilbestrol Injection.

#### CORPUS LUTEUM N.F. (CORPUS LUTEUM)

**Synonyms.**—*Desiccated Corpus Luteum*, Powdered Desiccated Corpus Luteum, Corpora Lutea.

**Definition.**—The dried, undefatted and powdered corpus luteum from the ovary of cattle, sheep and swine.

**Purity Rubric.**—Corpus Luteum is derived from sound, clean glands freed as far as practicable from other ovarian tissue, and yields not more than 6 per cent. of moisture and not more than 6 per cent. of total ash. It is free from diluents and preservatives.

One part of Corpus Luteum is obtained from approximately 5 parts by weight of the fresh corpus luteum. It should be dried in a vacuum, at a temperature not exceeding 60°C.

**Production.**—Corpus luteum is formed in the ovary as follows: After rupture of a Graafian follicle and the escape of its contents, the cavity of the follicle is partly occupied by a blood clot (the *corpus rubrum*). The follicle cells then proliferate, enlarge and undergo fatty changes becoming transformed into lutein cells, forming a yellow or orange mass termed the "*corpus luteum*." If impregnation of the ovum occurs, the corpus luteum greatly enlarges; if it does not take place, the corpus luteum atrophies and is ultimately replaced by scar tissue (*corpus albicans*).

**Powdered Desiccated Corpus Luteum.**—A yellow to buff-colored amorphous powder with a characteristic, malt-like odor and a saline taste. It is partly soluble in water, alcohol, petroleic ether and ether. The color varies with the stage of pregnancy of the animal and with its age.

The histological features of this product are as follows:

Numerous hypertrophied, yellowish lutein cells occurring singly or in small groups or irregular masses, the lutein cells polyhedral, ovoid, oblong to irregularly elongated with a rounded, central nucleus staining deep blue and cytoplasm staining purple with Delafield's hematoxylin, many of these cells containing fat globules and lutein granules which take a black color with osmic acid T.S. the lutein cells and granules staining greenish to greenish blue in 10 per cent. sulfuric acid; between various lutein cells in a clump occurs collagen fibers which are colored deep red with acid fuchsin T.S. and bluish with a mixture of Mallory's stain and 1 per cent. phosphotungstic acid; occasional capillaries of cylindrical shape, sometimes branched, hyaline, and showing dark outlines in 1 per cent. silver nitrate solution; somewhat cylindrical fragments of arterioles and veins whose severed ends exhibit somewhat rounded lumina and serrate or crenate



margins of endothelial cells having dark outlines when mounted in silver nitrate T.S.; very few non-medullated nerve fibers, the axon-colored mauve with eosin and hematoxylin, the fibrillæ clearly seen in a mixture of phosphotungstic acid and Mallory's stain; a few spindle-shaped, smooth muscle fibers with central nucleus colored deep blue with Delafield's hematoxylin; occasional amyloid bodies colored purple to violet with iodine water; a faint yellow, colorless crystalline substance.

**Constituents.**—A hormone called *progesterone*, *progestin*, and *corporin* which prepares the endometrium for the implantation of the ovum, checks the action of  $\alpha$ -estradiol, and prevents further ovulation during pregnancy; protein, etc. Progesterone is responsible for the maintenance of pregnancy.

**Uses.**—In menstrual and menopause disorders.

**Average Dose** (Corpus Luteum).—To be determined by the prescriber.

#### PROGESTERONE U.S.P. (PROGESTERONUM)

**Progesterone** ( $C_{21}H_{30}O_2$ ) is the hormone of the corpus luteum which may be synthesized from sterols. It occurs as a white crystalline powder which is practically insoluble in water, sparingly soluble in vegetable oils and soluble in alcohol, dioxane and acetone. Progesterone is used by parenteral injection in habitual and threatened abortion and in excessive periodic disorders. Average dose, Intramuscular, 5 mg. ( $\frac{1}{12}$  gr.). **Preparation.**—Injection.

Progesterone in oil solution is available under various trade names, as Proluton, Lutocyclin, Progestone, etc.

**Allied Drug.**—Anhydrohydroxyprogesterone U.S.P. is a derivative of progesterone. It is also known under various trade brands as Ethisterone, Pranone, Progestoral, etc. It is active orally. It is used in functional dysmenorrhea. Av. dose, 10 mg. ( $\frac{1}{6}$  gr.).

#### UNOFFICIAL DRUGS OBTAINED FROM PREGNANCY URINE

During pregnancy in the females of certain mammals (women and mares) estrogenic substances occur in large amounts in the urine, placenta, amniotic fluid, umbilical cord, blood and foetal blood. A number of active preparations obtained from pregnancy urine and placenta are available on the market.

#### ESTROGENIC SUBSTANCES (WATER INSOLUBLE) (AMNIOTIN) N.N.R.

**Definition.**—A highly concentrated, noncrystalline preparation of estrone together with a small amount of other estrogenic phenolic ketones extracted from the urine of pregnant mares.

**Assay.**—It is assayed by a modification of the Coward and Burn method in comparison with the international standard. Its potency is expressed in terms or the international unit.

**Uses.**—It is administered either orally, by hypodermic injection of an oil solution or intravaginally for the same purposes as estrone and estriol, in the treatment of symptoms of the menopause syndrome.

**Dose.**—From 2000 to 20,000 International Units injected one or more times weekly depending upon the patient's response. For gonorrheal vaginitis in children, from 1000 to 2000 I.U. in glycerogelatin suppositories, supplemented when necessary by intramuscular injections of the oil solution. For oral administration the drug is available in capsules containing respectively 1000, 2000 and 4000 I.U.

**International Unit for Estrogens.**—This is defined by the League of Nations Health Organization as the specific estrus producing activity contained in 0.1 microgram (0.0001 mg.) of the standard crystalline ketohydroxyestrin.

The appearance of cornified cells in the vaginal smear of a castrated rat is recognized as the physiologic criterion of activity of an estrogen preparation.

#### ESTROGENIC SUBSTANCES—WATER SOLUBLE (PREMARIN) N.N.R.

**Definition.**—A preparation containing the naturally occurring water soluble, conjugated forms of the mixed estrogens obtained from the urine of pregnant mares.

**Uses.**—For the control of menopausal symptoms, senile vaginitis, kraurosis vulvæ and pruritus vulvæ.

**Dosage.**—1.25 to 3.75 mg. daily. **Preparation.**—Tablets.

#### CHORIONIC GONADOTROPIN (FOLLUTEIN) N.N.R.

**Definition.**—The water-soluble gonadotropic substance obtained from the urine of pregnant women.

**Standard.**—One international unit is equivalent to 0.1 mg. of a standard powder (see Council Rept., Jour. A.M.A. 113 (Dec. 30, 1939), 2418).

**Uses.**—In cryptorchidism where anatomic lesions causing obstruction to the descent of the testes are absent.

**Dose.**—From 200 to 500 international units, 2 to 3 times a week.

**Follutein (Squibb) Korotrin (Winthrop) N.N.R.** are brands of chorionic gonadotropin which are standardized and available in vials containing from 100 to 5000 or more International Units of the active agent. The vials contain a powdered preparation of chorionic gonadotropin and are accompanied by an ampul of sterile distilled water containing a small percentage of phenol or metacresol which is intended as a diluent.

#### TESTOSTERONE

**Testosterone** ( $C_{19}H_{28}O_2$ ) or the primary male sex hormone is a substance secreted by the interstitial cells of the testes.

It was first isolated from testicular tissue by McGee in 1927. Male sex hormone is stated to be formed by the testes from puberty to late middle life. It passes into the general circulation and exerts its effects upon the organs and tissues and is later broken down to androsterone, dehydroisoandrosterone and other excretory products which are excreted in the urine. It stimulates the development of the seminal vesicles, penis and other parts of the male reproductive system, also the secondary male characteristics, including growth of beard,

depth of voice, and normal development of the prostate gland. When administered to females, it inhibits the female genital functions evidently by checking the gonadotropic functions of the anterior pituitary. Av. dose by implantation, 0.3 Gm. **Preparation.**—Pellets.

Testosterone is esterified in order to prolong its action, the chief product made thereby being *testosterone propionate*. It is now produced synthetically from cholesterol. Its potency is 100 I.U. per mg.

**Testosterone Propionate (Testosteroni Propionas) U.S.P.** occurs as white or slightly yellow crystals or crystalline powder which is soluble in vegetable oils, alcohol, etc., but insoluble in water. Average dose, Intramuscular, 25 mg. ( $\frac{3}{8}$  gr.). **Preparation.**—Testosterone Injection.

**Methyltestosterone (Methyltestosteronum) U.S.P.** occurs similarly but is only sparingly soluble in vegetable oils. Average dose, Oral 10 mg. ( $\frac{1}{6}$  grain); Sublingual, 5 mg. ( $\frac{1}{12}$  grain).

**Uses.**—In the male climacteric (functional hypogonadism) to restore endocrine balance, for the symptomatic relief of prostatism, in dysfunctional uterine bleeding, for the suppression of unwanted lactation, etc.

It is administered by intramuscular injection, or orally in the form of tablets containing a methyl derivative ( $C_{20}H_{30}O_2$ ), or by inunction of the methyl derivative in a suitable base.

Testosterone propionate is available in ampuls under various trade brands, such as "Oreton" (Schering), "Perandren" (Ciba) and "Neo-Hombreol" (Roche). The tablets of methyl testosterone for oral administration are available under trade brands, as "Oreton-M" (Schering), "Neo-Hombreol-M" (Roche) and "Metandren" (Ciba).

#### INSULIN INJECTION U.S.P. (INJECTIO INSULINI)

**Synonyms.**—*Insulin, Insulin Hydrochloride.*

**Definition.**—Insulin Injection is an acidified solution of the active principle of the pancreas which affects the metabolism of glucose.

**Standard of Assay.**—Insulin Injection, when assayed as directed (on healthy rabbits weighing at least 1.5 Kg.), shall possess a potency of not less than 95 per cent. and not more than 105 per cent. of the potency stated on the label, and the potency shall be expressed in U.S.P. Insulin Units which are equivalent in potency to the Unit declared on the label of the U.S.P. Zinc-Insulin Crystals Reference Standard. The *test animals* employed in the Insulin assay are healthy rabbits weighing at least 1.5 Kg. For details of assay see U.S.P. Insulin is so standardized that each cc. contains either 40, 80 or 100 U.S.P. Insulin Units. It must meet the requirements of the U.S.P. test for sterility of liquids.

**History.**—In 1899 Mering and Minkowski found that the internal secretion of the pancreas had an important role in sugar metabolism. Later it was found that lesions of the gland or extirpation were followed by diabetes and that lack of this secretion was associated with this disease. After the treatment of diabetes with extracts of whole pancreas it failed to abate the symptoms. It remained for Banting and Best in 1920–1922 to prepare extracts from the pancreas, the glandular tissues of which had been caused to degenerate by liga-

tion of the pancreatic duct. These, when injected into depancreatized dogs, removed the cardinal symptoms of diabetes (high blood-sugar and sugar in the urine). The tissue of the Islands of Langerhans remained intact and yielded an extract containing the secretion called insulin free from pancreatic enzymes. Later insulin was obtained from fresh whole pancreas by extracting it with 60 per cent. to 95 per cent. alcohol containing a small per cent. of sulfuric acid which prevents any action by enzymes during the process. This method is in

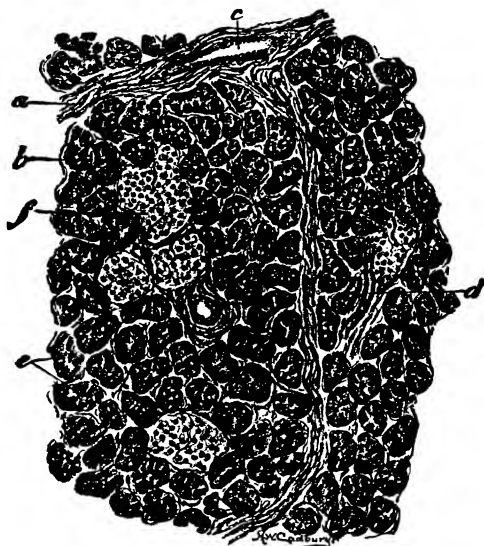


FIG. 510.—Section of human pancreas, magnified, showing several islets of Langerhans. (Radasch.) *a*, interlobular connective tissue, containing an interlobular duct; *c*; *b*, capillary; *d*, interlobular duct; *e*, alveoli; *f*, islet of Langerhans. (From Morris.)

use today. The acidified alcoholic solution is next concentrated and the insulin precipitated by ammonium sulfate and the sulfate precipitate dissolved in dilute ammonia and impurities removed by reprecipitation from alcoholic solution. It is further purified by a method of iso-electric precipitation. This precipitate is centrifuged and dissolved in acid water, the solution diluted to the approximate desired potency, passed through a Berkefeld filter and submitted to standardization and sterility tests. The U.S.P. permits Insulin to be prepared from zinc-insulin crystals. In 1926 Abel isolated pure crystalline insulin from extract of pancreas.

**Description.**—A colorless or nearly colorless liquid, free from turbidity and from insoluble matter. It must contain from 0.1 to 0.25 per cent (w/v) of either phenol or cresol and from 1.4 to 1.8 per cent (w/v) of glycerin.

**Storage.**—Insulin must be preserved at a temperature above 0°C. but not exceeding 15°C., avoiding freezing. It must be dispensed in a satisfactory unopened multiple dose 10-cc. glass container in which it was placed by the manufacturer.

**Labeling.**—The label of the Insulin container and the outside label of each retail package must state the potency in U.S.P. Insulin Units per cc. The outside retail package label must also state an expiration date which must not be later than 2 years after the date of its removal for distribution from the manufacturer's place of storage, the temperature of which shall be above 0°C. but shall not exceed 15°C.

**Use.**—In diabetes mellitus which cannot be controlled by dietetic treatment. It is also used in the shock treatment of schizophrenia.

**Dose.**—There is no average dose; each case has its own requirement, the dose being dependent upon the amount of dextrose in such a diet as the patient is unable to metabolize. Insulin is administered by injection into the loose subcutaneous tissue of the body usually one half hour before meals. At times it is administered intravenously.

PROTAMINE ZINC-INSULIN INJECTION U.S.P.  
(INJECTIO ZINCO-INSULINI PROTAMINATI)

**Definition.**—A suspension, in a buffered water medium, of Insulin modified by the addition of protamine and zinc chloride. The protamine is prepared from the sperm or from the mature testes of fish belonging to the genera *Oncorhynchus* Suckley, *Salmo* Linné, or *Trutta* Jordan and Evermann (Fam. *Salmonidae*), and conforms to the regulations of the Food and Drug Administration concerning certification of batches of drugs composed wholly or partly of insulin.

**Standard of Assay.**—The amount of insulin used in the preparation of Protamine Zinc-Insulin is sufficient to provide either 40 or 80 U.S.P. Insulin Units for each cc. of Injection.

**Production.**—Protamine zinc insulin was developed by Dr. H. C. Hagedorn and his associates of Copenhagen, Denmark. It is prepared by mixing insulin, protamine from the roe of the salmon or rainbow trout, and zinc with a buffered solution containing disodium acid phosphate and approximately 1.6 per cent. of glycerin, the whole brought into a uniform suspension and standardized so that each cc. contains either 40 or 80 units of insulin, 1.25 mg. of protamine and 0.2 mg. of zinc per 100 units of insulin. Small amounts of cresol or phenol are added as a preservative. It is marketed in 10 cc. sterile vials, the label on the package indicating the manufacturer's name, the number of units per cc., etc. Like unmodified insulin, it should be stored in a cold place at a temperature above 0° but not above 15°C. and freezing must be avoided.

**Uses.**—It is used by subcutaneous injection in diabetes mellitus either per se or supplementing treatment with unmodified insulin. It is never administered intravenously. Its advantages over insulin are (1) that it enables the body to utilize about 20 per cent. more dextrose per unit, (2) it has a more prolonged blood-sugar-lowering action than the unmodified insulin and this action lasts about 24 hours, and (3) it requires lower dosage and fewer injections.

**Average Dose.**—To be determined by the physician in accordance with the needs of the patient.

## ANIMAL DRUGS FROM VARIED SOURCES

## PURIFIED ANIMAL CHARCOAL N.F. (CARBO ANIMALIS PURIFICATUS)

**Synonyms.**—Bone Black, Ivory Black; *Ger.* Thierkohle; *Fr.* Charbon Animal Ordinaire.

**Definition.**—Charcoal prepared from bone and purified by removing the substances which are dissolved by hot HCl and water.

**Description.**—An odorless and tasteless dull black powder, insoluble in water, alcohol or other ordinary solvents. It burns with a red glow but without a flame.

**Uses.**—Absorbent. Decolorizing agent.

**Average Dose.**—0.3 Gm. (5 grains).

## GELATIN U.S.P. (GELATINUM)

**Synonyms.**—*Ger.* Weisser Leim, Gallerte; *Fr.* Gélatine Officinale.

**Definition.**—A product obtained by the partial hydrolysis of collagen, derived from the skin, white connective tissue and bones of animals. Gelatin derived from an acid-treated precursor, exhibits an isoelectric range between pH 7 and pH 9, while Gelatin derived from an alkali-treated precursor has an isoelectric point between pH 4.7 and pH 5.0.

**Production.**—Clean bones and other animal tissues are selected. The bones are first treated with HCl to remove calcium phosphate and other mineral matter. The combined animal matter is boiled with water, purified by treatment with animal charcoal if sparkling gelatin is to be prepared, the solution strained, concentrated and allowed to gelatinize. The soft gelatin is cut into slabs and placed on netting and dried rapidly by exposure to currents of warm air. The resultant product is sheet gelatin.

**Description.**—In sheets, shreds, flakes or powder, colorless or yellowish and possessing a very slight bouillon-like odor and taste; soluble in hot water, in a hot solution of glycerin and water, and in acetic acid. It is liable to microbic decomposition when moist or in solution.

**Uses.**—Nutrient; in preparation of culture media, as an emulsifier, to coat pills, as a vehicle in making glycerogelatin suppositories, and in forming capsules.

**Preparations.**—Glycerinated Gelatin U.S.P. Ephedrine Sulfate Jelly N.F. Absorbable Gelatin Sponge.

## VITAMINS

**Vitamins** are nutritive substances essential for the maintenance of normal metabolic functions. They occur in many foods and act as catalysts of life processes. Their absence in sufficient amounts in the diet accounts for various deficiency diseases. The following vitamins, vitamin factors and preparations, not considered in previous pages of this text, are recognized in the U.S.P. XIII:

**Ascorbic Acid (Acidum Ascorbicum).** *Vitamin C.* Antiscorbutic; in scurvy and sub-clinical scurvy. Av. Dose, To be determined by the physician according to the needs of the patient. Prep.—Ascorbic Acid Tablets. Sodium Ascorbate Injection.

**Nicotinic Acid (Acidum Nicotinicum).** *Niacin*, P-P. factor. Used in pellagra. Av. Dose, 25 mg. ( $\frac{3}{8}$  gr.). Prep.—Nicotinic Acid Tablets.

**Nicotinamide (Nicotinamidum).** *Nicotinic Acid Amide, Niacinamide.* Used in pellagra. Av. Dose, 25 mg. ( $\frac{3}{8}$  gr.). Prep.—Nicotinamide Injection, Parenteral, 100 mg. ( $1\frac{1}{2}$  grains); Nicotinamide Tablets. Nicotinamide Capsules.

**Thiamine Hydrochloride (Thiaminæ Hydrochloridum).** *Vitamin B<sub>1</sub>, Aneurine Hydrochloride.* In neurasthenia. Av. Dose.—To be determined by the physician according to the needs of the patient. Prep.—Tablets, Injection.

**Riboflavin (Riboflavinum).** *Vitamin B<sub>2</sub>, Lactoflavin.* Used in pellagra, keratitis, cheilosis, etc. Av. Dose.—To be determined by the physician according to the needs of the patient. Prep.—Riboflavin Injection, Riboflavin Tablets.

**Oleovitamin A (Oleovitamina A).** *Natural Vitamin A in Oil.* Av. Daily Dose (unof.).—Prophylactic, infants and adults, 0.1 cc. ( $1\frac{1}{2}$  minims). Av. Dose.—To be determined by physician. Prep.—Oleovitamin A Capsules. Av. Daily Prophylactic Dose.—One capsule, containing 5000 U.S.P. Vitamin A Units.

**Oleovitamin A and D (Oleovitamina A et D).** This is either fish liver oil, or fish liver oil diluted with an edible vegetable oil, or a solution of Vitamin A and D concentrates in fish liver oil or in an edible vegetable oil. Av. Daily Dose, infants and adults, 8 cc. (2 fl. dr.).

**Concentrated Oleovitamin A and D (Oleovitamina A et D Concentrata).** Av. Daily Dose (unof.) Prophylactic, infants and adults, 0.1 cc. ( $1\frac{1}{2}$  minims). Prep.—Concentrated Oleovitamin A and D Capsules. Av. Daily Prophylactic Dose, one capsule.

**Synthetic Oleovitamin D (Oleovitamina D Synthetica).** A solution of activated ergosterol (Vitamin D<sub>2</sub>), or activated 7-dehydro-cholesterol (Vitamin D<sub>3</sub>) in an edible vegetable oil. It contains in each Gm., not less than 10,000 U.S.P. Units of Vitamin D. Av. Daily Dose (unof.).—Prophylactic, 0.1 cc. ( $1\frac{1}{2}$  minims). Av. Dose.—To be determined by the physician.

**Menadione (Menadionum)** *2-methyl naphthoquinone (C<sub>11</sub>H<sub>8</sub>O<sub>2</sub>).* Syn.: Synthetic Vitamin K, *Menaphthone*, Anti-hemorrhagic Vitamin. Used in hemorrhages due to a low prothrombin content of the blood. Av. Dose, 1 mg. ( $\frac{1}{60}$  gr.). Prep.—Menadione Tablets, Menadione Injection, Menadione Sodium Bisulfite, Menadione Sodium Bisulfite Injection.

**Hexavitamin Capsules (Capsulæ Hexavitaminarum) and Hexavitamin Tablets (Tabellæ Hexavitaminarum).** These contain in each capsule or tablet not less than 5000 U.S.P. Units of Vitamin A from natural (animal) sources, 400 U.S.P. Units of Vitamin D from natural (animal) sources or as activated ergosterol or activated 7-dehydrocholesterol, 75 mg. of ascorbic acid, 2 mg. of thiamine hydrochloride, 3 mg. of riboflavin, and 20 mg. of nicotinamide. Used in avitaminosis requiring multiple vitamin therapy. Av. Dose.—To be determined by the physician according to the needs of the patient.

## FOLIC ACID

**Folic Acid** (*Acidum Folicum*), also known as pteroyl glutamic acid, Vitamin B<sub>9</sub>, Vitamin M and synthetic L. casei factor is a synthetic member of the Vitamin B complex which was introduced into medicine in 1945 by Spies and his associates who found it effective in the treatment of macrocytic anemia. Its discovery was the result of cumulative investigations in which this antianemia principle had been found to occur in dried brewer's yeast, spinach and liver extract. It was named "folic acid" by Mitchell, Snell and Williams in 1941 who obtained the material from spinach.

**Uses.**—In the treatment of nutritional macrocytic anemia, in pernicious anemia as an adjunct to liver therapy, and in sprue.

**Dose.**—5 to 20 mg. daily, orally or parenterally. Av. daily dose, 10 mg.

**Preparations.**—Tablets of Folic Acid and Dried Ferrous Sulfate, Folic Acid Elixir, Folic Acid Tablets, Folic Acid Capsules.

**Vitamin B Complex.**—A group of substances formerly known as Vitamin B of which the following have been identified and synthesized: Thiamine, or Vitamin B<sub>1</sub>, Riboflavin or Vitamin B<sub>2</sub>, Nicotinic Acid, Nicotinamide, Pyridoxine or Vitamin B<sub>6</sub>, Pantothenic Acid, Biotin, and Folic Acid. A number of preparations of Vitamin B Complex are available among which are Dried Yeast, Dried Yeast Tablets, Brewers Yeast (powder and tablets), Vitamin B Complex Syrup and Yeast Extract. All of these are used in the treatment of Vitamin B Complex nutritional deficiency and as an adjunct to insulin in certain cases of diabetes mellitus.

**Vitamin E.**—This vitamin was discovered in Wheat Germ Oil, in 1922, by Evans and his associates who found it to contain *tocopherols*. One of these,  $\alpha$ -tocopherol, is a pale yellow oily liquid without odor. Vitamin E is used in the treatment of habitual abortion either in the form of wheat germ oil (see p. 142), the usual daily dosage of which is 1 fl. dr., or as  $\alpha$ -tocopherol in daily dosages of from 20 to 30 mg. It has also been used in the form of the acetate ester, and in an ointment of wheat germ oil, the latter applied locally in fibrositis.

**Vitamin B<sub>12</sub>** is a cobalt-containing substance obtained from liver or produced by the growth of suitable microbes. It occurs as red crystals which are sparingly soluble in water and soluble in alcohol. It is used in Addisonian pernicious anemia in the form of Vitamin B<sub>12</sub> Injection. Av. Dose—15 micrograms.



# CHAPTER III

## ANTIBIOTICS AND BACTERIAL BIOLOGICAL PRODUCTS

### ANTIBIOTICS

An antibiotic is an antimicrobial agent produced by or derived from living cells of bacteria, molds or other plants.

#### PENICILLIN

Penicillin is an antibiotic substance or substances produced by the growth of *Penicillium notatum* Westling and *Penicillium chrysogenum* Thom (Fam. *Aspergillaceæ*).

**History.**—In 1928, while Dr. Alexander Fleming of St. Mary's Hospital, London was observing a growth of staphylococci on a blood agar plate which was contaminated with a *Penicillium* mold, he noticed a clear broad zone of inhibition around the mold colony and that other colonies of staphylococci on the plate were more or less transparent. He concluded the clear zone was due to lysis of the staphylococci by some substance secreted by the mold and, in 1929, reported his observation that the *Penicillium* mold elaborated a substance which inhibited the growth of bacteria. He called this substance, "penicillin."

In 1932, he reported that he had used filtrates of broth cultures of *Penicillium* containing penicillin successfully in treating indolent septic wounds by local application. Fleming first tentatively called his mold *Penicillium rubrum* but it was later identified by Thom as *Penicillium notatum* Westling.

In 1938, H. W. Florey and E. Chain first isolated penicillin in impure form and demonstrated its high germicidal activity against streptococci, staphylococci, pneumococci, gas gangrene clostridia and diphtheria bacilli. Florey later reported on the purification of penicillin. In 1941, he and N. G. Heatley came to the United States under the auspices of the Rockefeller Foundation. They were instrumental in influencing Drs. Coghill and Moyer of the Fermentation Division of the U.S. Dept. of Agriculture's research laboratory at Peoria, Illinois, to initiate studies on the culture of *Penicillium notatum* and to develop new methods which led to large scale production of penicillin. It was found during these researches that *Penicillium chrysogenum* Thom, a closely related species, also produced penicillin when grown on nutrient media. Sufficient penicillin is now being produced to meet the needs of the civilian and military demands in this country.

**Plants.**—*Penicillium notatum* is a blue-green mold forming floccose colonies with a white margin on gelatin, the latter being liquefied. It possesses slender

submerged hyphæ and septated aerial hyphæ from which branched, brush-like conidiophores arise,  $2.8\mu$ – $4.6\mu$  in breadth and up to about  $750\mu$  in length, bearing 3 metulæ, each with its sterigmata from the tips of which are borne moniliform chains of subglobose conidia up to  $3.2\mu$  in diameter. *Penicillium chrysogenum* Thom is a closely related species.

**Production.**—The spores (conidia) from a pure culture of *Penicillium*



FIG. 511.—Alexander Fleming's original *Staphylococcus* plate accidentally contaminated with *Penicillium notatum*. (From "The Seminar," Vol. 8, No. 1.)

*notatum* or *P. chrysogenum* are introduced into a nutrient medium containing 4 per cent. of lactose in a flattened, wide-mouthed bottle (*surface or bottle process*) or into corn-steep liquor or other suitable nutrient media in fermentation tanks (*deep fermentation process*). In the nutrient medium the spores germinate to form a mycelium which excretes penicillin into the substrate. The mycelium is separated from the liquid medium containing the penicillin. The crude penicillin recovered therefrom is purified and dehydrated under vacuum, tested for potency by the Oxford Cup Assay method, also for sterility and pyrogens,

and packaged in rubber-stoppered, serum-type vials, each vial containing from 100,000 to 300,000 Oxford units. The Oxford Cup Assay method is employed for determining the potency of penicillin in the material or product in units. In this method the unit is that amount of penicillin which produces the same degree of inhibition of growth of the test microorganism *Staphylococcus aureus* H as the standard preparations of penicillin kept by the Oxford workers.

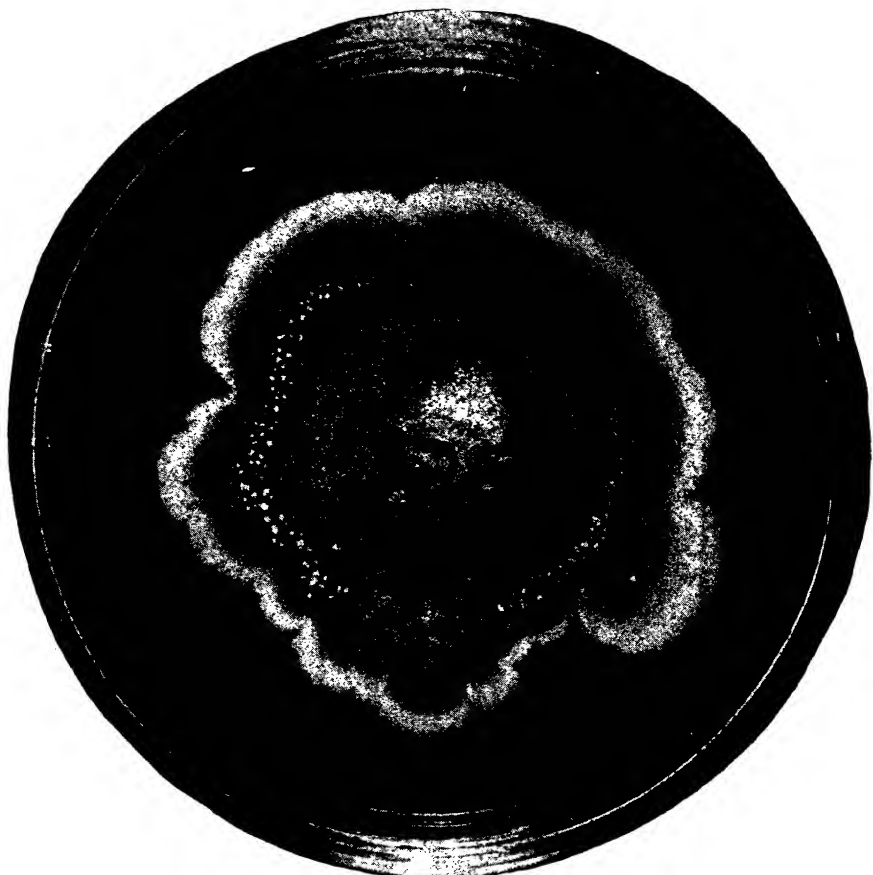


FIG. 512.—Colony of *Penicillium notatum* growing on *Staphylococcus* pour plate. The penicillin produced by the colony inhibits the growth of the staphylococci. (From "The Seminar," Vol. 8, No. 1.)

The zone of inhibition which develops around the cup measures from 23 to 24 mm. in diameter.

The Oxford or Florey unit is that amount of Penicillin which, when dissolved in 1 cc. of water and tested by the Oxford method, produces a degree of inhibition against the *Staphylococcus aureus* 209 P equal to that produced by one unit of standard penicillin. The present International unit is equal to the Oxford unit and is based on the sodium salt of penicillin with a value of 1667 units per

mg. One unit of Standard Penicillin is equivalent to about  $\frac{1}{1650}$  mg. of purified penicillin.

The U.S. Food and Drug Administration has set up standards for the control of the manufacture of Penicillin in this country. It has set up a "Master Standard" of pure crystalline sodium penicillin G of a potency of 1650 units per milligram which it designates as the standard of comparison in determining the



FIG. 513.—*Penicillium notatum* Westling, showing growth habit. Note the septated, brush-like aerial hyphae, to left and in center and the stoloniferous hyphae, also septated, in upper right of photomicrograph. (Courtesy, Sharp and Dohme.)

potency of the "Working Standard." The term "unit" used by the U.S.P. means the penicillin activity contained in 0.6 microgram of the Penicillin Master Standard.

Penicillin has been found to be an organic acid which reacts chemically to form salts and esters. Under the microscope it appears as whetstone-shaped crystals. Its sodium and calcium salts are amorphous white to brown powders. These and preparations of them were introduced into the U.S.P. XIII.

**Penicillin Calcium U.S.P. (Penicillinum Calcicum)** is the calcium salt of an antibiotic substance or substances produced by the growth of *Penicillium notatum* Westling or of *Penicillium chrysogenum* Thom (Fam. *Aspergillaceae*), or produced by any other means.

**Penicillin Sodium U.S.P. (Penicillinum Sodicum)** is the sodium salt of an antibiotic substance or substances produced by the growth of *Penicillium notatum* or of *Penicillium chrysogenum*, or produced by any other means.

**Potency.**—The U.S.P. specifies two standards of potency dependent upon whether the official penicillin salts are used for injection or for oral administration, as follows:

**Penicillin Calcium or Penicillin Sodium for Injection.**—Not less than 500 units for each milligram except when it contains not less than 90 per cent of a salt of Penicillin X, its potency is not less than 350 units for each mg. When used for preparing Penicillin Injection in Oil and Wax, the Penicillin Calcium must have a minimum potency of 750 units in each mg. for concentrations of 100,000 to 200,000 units in each cc.

**Penicillin Calcium and Penicillin Sodium for Oral Administration** (for making tablets or troches or dental cones).—Not less than 300 units for each mg.

**Description.**—Both Penicillin Calcium and Penicillin Sodium occur as a white to brown powder or as scales or granules which are odorless or with a slight characteristic odor. They are very soluble in water, in dextrose solution and in isotonic sodium chloride solution. In solution at room temperature, they lose potency, but their solutions kept at below 5°C. remain stable for about 10 days. Oxidizing agents, glycerin and alcohol destroy the activity of penicillin. Acids and the salts of heavy metals precipitate it from solution.

**Storage.**—Penicillins must be stored in hermetic or other suitable containers at not above 15°C.

**Uses.**—As a bacteriostatic and germicide in the treatment of wound infections, carbuncles, anthrax, pneumococcic infections, gonorrhea, meningitis, syphilis, relapsing fever, mastoiditis, peritonitis, actinomycosis, gas gangrene, etc. Sterile, pyrogen free solutions of penicillins are used in various concentrations intramuscularly, intravenously, intrathecally and topically.

**Average Daily Dose.**—Oral on a fasting stomach, 300,000 units; Intramuscular, 300,000 units.

**Preparations in U.S.P.**—Penicillin Dental Cones, 1 cone; Penicillin Injection in Oil and Wax, Intramuscular, 300,000 units, daily; Penicillin Ointment; Penicillin Tablets, on a fasting stomach, 300,000 units, daily; Penicillin Troches, one troche.

**Procaine Penicillin** is a compound produced by combining one molecule of penicillin with one molecule of procaine. It is more slowly absorbed than penicillin and so provides prolonged and more effective blood levels, insuring to a greater degree that the infectious organism, if susceptible to penicillin therapy, will be destroyed. Owing to its additional anesthetic action, there is less discomfort to the patient. It is available in 1 cc. (300,000 units) disposable syringes and multiple dose vials (300,000 units per cc.) in oil.

### STREPTOMYCIN

**Definition.**—Streptomycin is an antibiotic substance produced by certain strains of *Streptomyces griseus* (Krainsky) Waksman and Henrici (Order *Actinomycetales*).

**History.**—The isolation of Streptomycin was announced early in 1944 by A. Schatz, E. Bugie and S. A. Waksman of the New Jersey Agricultural Experiment Station, Rutgers University. Subsequent researches by these and other workers have shown it to be useful in treating many diseases for which other antibiotics are ineffective and that it showed a low toxicity for animals. The

potency of Streptomycin was originally expressed in terms of the "S" unit which represented that amount of material which, when present in 1 ml. of a nutrient medium would just inhibit the growth of a given strain of *Escherichia coli*.

**Standard.**—One unit of Streptomycin is equivalent to one microgram (gamma) of pure streptomycin base. It is generally standardized against either *Escherichia coli*, *Bacillus subtilis* or a special strain of *Staphylococcus aureus*.

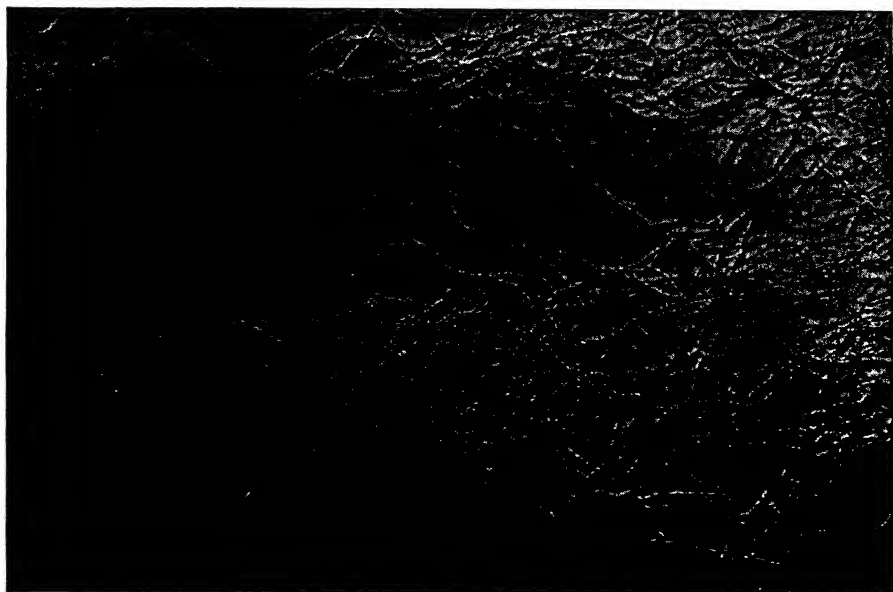


FIG. 514.—*Streptomyces griseus* growing on agar substrate. (Courtesy, Merck and Co.)

**Production.**—Streptomycin is produced by the deep submerged culture type of fermentation, corn-steep liquor or other suitable nutrient medium being employed for the growth of *Streptomyces griseus*.

**Description.**—Streptomycin occurs both as the hydrochloride and the sulfate in the form of a white, hygroscopic powder, extremely soluble in water but insoluble in the common organic solvents. Its activity is reduced by dextrose, phosphates, carbon dioxide, ascorbic acid, etc. It is supplied in sterile, rubber-stoppered vials, each containing an amount equivalent to the amount of pure streptomycin base stated on the label.

**Uses.**—As a bacteriostatic and germicide in tularemia, in *Hemophilus influenzae* infections, in bacteremia from gram-negative organisms, urinary tract and other infections caused by *Escherichia coli*, *Proteus vulgaris*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Aerobacter aerogenes*, *Bacillus paratyphosus*, in the treatment of meningitis, chronic pulmonary infections, empyema, liver abscesses and cholangitis caused by gram-negative organisms, in tuberculosis, and in endocarditis caused by penicillin resistant but streptomycin susceptible organisms. It is administered parenterally in sterile, pyrogen

free, isotonic solutions, also by topical application, nebulization, and for the purpose of reducing the bacterial flora of the intestinal tract, orally.

**Daily Dosage.**—From 0.5 to 4 Gm., according to the sensitivity of the pathogen to the drug, the severity and location of the infection and the presence of bacteremia.

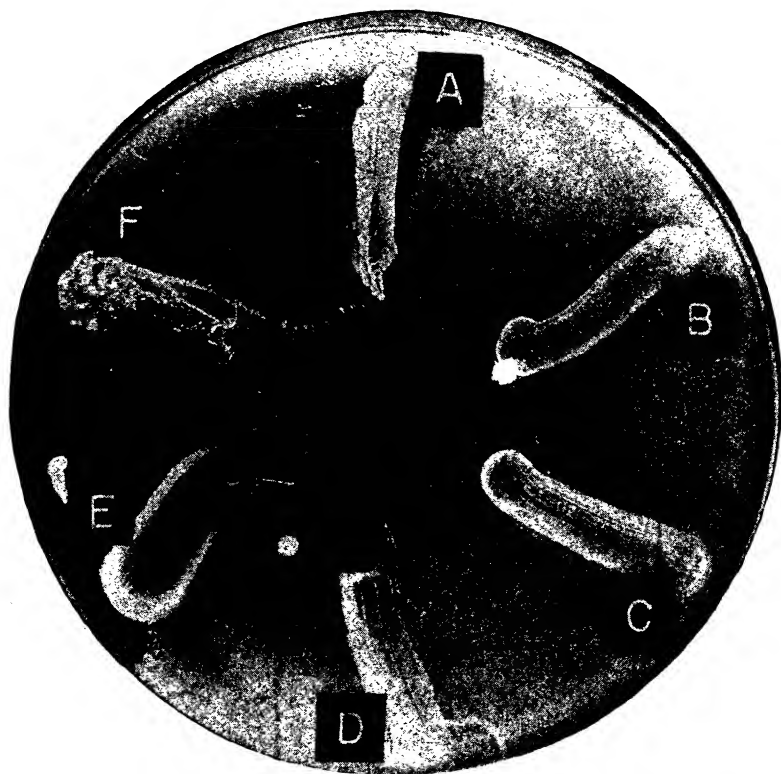


FIG. 515.—Agar plate containing 0.1 microgram of streptomycin per cc. of agar, showing the inhibitory effect of streptomycin on streak colonies of certain gram-negative and gram-positive microorganisms in vitro. A, *Escherichia coli*; B, *Eberthella typhosa*; C, *Proteus vulgaris*; D, *Klebsiella pneumoniae*; E, *Pseudomonas aeruginosa* (*Bacillus pyocyaneus*); F, *Mycobacterium tuberculosis*. (Courtesy of Merck and Co.)

#### TYROTHRICIN

Tyrothricin is a mixture of antibiotic substances extracted from cultures of *Bacillus brevis* Dubos (Fam. *Bacteriaceae*).

**History.**—In 1939, R. J. Dubos reported that he obtained an alcohol-soluble substance from autolyzed cultures of a motile, sporogenic, soil bacillus which proved active against certain gram-positive organisms (staphylococci, streptococci and pneumococci) in vitro. He called this substance gramicidin and the microorganism, *Bacillus brevis*. In 1940, Hotchkiss and Dubos discovered that the antibiotic material from the *B. brevis* cultures contained a second antibiotic substance which they found to be active against gram-negative microorganisms and which they named tyrocidine. They designated the mix-

ture of these two antibiotic substances (gramicidin and tyrocidine) as tyrothricin. Both of the constituents of tyrothricin have been isolated in pure crystalline form and found to be polypeptides.

**Production.**—Tyrothricin is prepared by the extraction of cultures of *Bacillus brevis* which have been allowed to undergo autolysis. The cultures



FIG. 516.—Agar plate containing 6.4 micrograms of streptomycin per cc. of agar, showing the bacteriostatic effect of streptomycin on the same organisms shown in Fig. 515 by a higher concentration of this antibiotic. All of the streak colonies of these organisms underwent complete lysis when grown on agar containing 10.4 micrograms of streptomycin per cc. of agar. (Courtesy of Merck and Co.)

are collected and precipitated, the precipitate extracted with alcohol, the alcoholic extract reprecipitated, defatted and dried. Alcoholic and propylene glycol solutions are prepared from the dried drug and the strength of tyrothricin in the vials or ampules is expressed in terms of percentage of concentration of the drug. The potency of each lot is tested for its ability to protect mice against type 1 pneumococcal infection.

The solutions supplied by the manufacturers are packaged in vials or ampules containing 2 to 2.5 per cent concentrates of tyrothricin in alcoholic solution. The concentrate is diluted to the desired strength by the dispenser by adding it very slowly to sterile, distilled water and agitating the water vigorously during the procedure.



**Uses.**—Topical applications of the solution by means of wet dressings, irrigations and instillations are employed in the treatment of superficial indolent ulcers, abscesses of the skin and soft tissues, the predominating causative organism of which is gram-positive, in mastoiditis, otitis media, sinusitis, osteomyelitis, pneumococcic conjunctivitis, pneumokeratitis, dendritic and punctate keratitis, epidemic keratoconjunctivitis, empyema caused by hemolytic streptococci, in blepharitis, infected wounds, carbuncles and furuncles.

**Dosage.**—By topical application only in concentrations of 0.1 to 0.5 mg. per cc. The usual concentration employed is 0.5 mg., per cc. which yields an isotonic solution. **Preparations.**—Tyrothricin Solution, Spray and Troches.

### CHLOROPHYLL

**Chlorophyll** is the green coloring matter of plants. In green plants it occurs in the chloroplastids or chromatophores of leaves and other green parts as a mixture of two green pigments (chlorophyll- $\alpha$  and chlorophyll- $\beta$ ) and two yellowish pigments (xanthophyll and carotin). So-called *Natural Chlorophyll* of commerce consists of a mixture of chlorophyll- $\alpha$  ( $C_{55}H_{72}O_5N_4Mg$ ) and chlorophyll- $\beta$  ( $C_{55}H_{70}O_5N_4Mg$ ). It is usually obtained from fresh or dried leaves, especially from those of spinach, nettles or alfalfa, by extraction with acetone. Both of these chlorophylls bear a chemical resemblance to the hemoglobin of the blood except that they contain magnesium whereas hemoglobin contains iron. Crystalline chlorophyll which is chiefly ethyl chlorophyllide is produced by extracting green leaves with alcohol instead of acetone.

A number of chlorophyll derivatives occur on the market. One group of these is produced by replacing the Mg in the chlorophyll with iron or copper, forming compounds known respectively as *iron pheophytin* and *copper pheophytin*. Water-soluble chlorophylls containing Mg are also available, the best known of which is probably sodium-magnesium chlorophyllin.

**Uses.**—The antibacterial activity of chlorophyll against staphylococci, hemolytic streptococci, etc. is believed to be due to its interference with the mechanism of bacterial respiration. It is known to produce an unfavorable environment for bacterial growth and to stimulate tissue repair. The natural chlorophylls and especially the water-soluble chlorophylls are employed by topical application, in the form of 0.2 to 0.5 per cent solutions in wet dressings and irrigation, also in ointments for the treatment of infected wounds, ulcers, bed sores, burns, osteomyelitis, sinusitis, empyema, etc. Iron pheophytin has been used in anemia. Copper pheophytin is used as a green coloring agent.

### BACITRACIN

**Definition.**—Bacitracin is an antibiotic substance obtained from the Tracy strain of *Bacillus subtilis* Cohn em Prazmowski (Fam. *Bacillaceae*).

**History.**—The organism producing bacitracin was discovered by Dr. Frank L. Meleney and Miss Balbina Johnson of the College of Physicians and Surgeons of Columbia University in 1945. They isolated an aerobic, gram-positive bacillus from cultures of the debrided tissue removed from an infected fractured

tibia of Margaret Tracy, a patient of Dr. Meleney. The crude filtrate of the cultured organism was found to protect mice against hemolytic streptococci when injected in strengths thousands of times more powerful than the minimum lethal dose. Later, H. Anker, in collaboration with the discoverers isolated the antibiotic substance as an amorphous slightly yellowish powder by extracting the filtrate with butyl alcohol. It was called "bacitracin" in honor of Miss Tracy.

**Unit of Bacitracin.**—A unit of bacitracin is the amount which when diluted 1:1024 completely inhibits the growth of a stock strain of Group A hemolytic *Streptococcus* (*Science*, 102: 376, 1945).

**Uses.**—As a bactericide against a wide range of microorganisms including pus forming and blood poisoning staphylococci, streptococci and gonococci; in the treatment of furuncles, ulcers, carbuncles, infected wounds, etc.

**Dosage.**—Locally in the form of an aqueous solution containing 100 units per cc. of solution as an injection into the center of the lesion, and in the form of a water-soluble ointment base containing 100 units of bacitracin per Gm. as an initial concentration. It has been found to be non-toxic and non-irritating when administered locally. It is not inhibited by blood, plasma, organisms producing penicillinase or necrotic tissue.

#### BACTERIAL BIOLOGICAL PRODUCTS

These include (1) Living Organisms intended for oral administration such as *Lactobacillus acidophilus*, (2) Serums such as Plain or Normal Serum, Antitoxic Serums or Antitoxin, Antibacterial Serums, and Antibody Solutions, (3) Toxins which may be Plain Toxins or Exotoxins, Neutralized Toxins or Toxin Antitoxin, Detoxified Toxins or Toxoids, and Culture Filtrates, (4) Vaccines which may contain (a) living organisms as Smallpox Vaccine, (b) killed organisms as in Bacterial Vaccines or Bacterins or (c) sensitized killed organisms as in Sero-Bacterins, (5) Tuberculins, (6) Protein Antigens and (7) Transmissible Lytic substances or Bacteriophages.

*Antitoxins* consist of sterile aqueous solutions of antitoxic substances dissolved in freshly distilled water with an added preservative. They produce passive immunity.

An *antibacterial serum* is a serum separated from the plasma obtained from the blood of an immunized animal and containing antibody substances specific for the bacterial culture employed as the antigen.

An *antigen* is any substance which when injected into an animal causes the body tissues of that animal to react and produce antibodies specific in action against the antigenic substance.

A *toxin* (exotoxin) is a soluble toxic product of a bacterial cell which is capable of diffusing out of the living cell into the surrounding medium. Toxins are used as antigens to produce active immunity.

A *toxin-antitoxin* is a mixture of toxin and antitoxin in which the amount of toxin slightly exceeds the amount of antitoxin. It is used to produce active immunity. Example: Diphtheria Toxin-antitoxin.

A *toxoid* is a toxin which has had its toxic properties neutralized or destroyed. It is used to develop active immunity. Example: Diphtheria Toxoid.

A *vaccine* is a suspension of living or dead antigenic substances. It is used for the development of active immunity. Examples: Vaccinum Variolæ, Vaccinum Rabies.

A *bacterin* or *bacterial vaccine* is a suspension of killed pathogenic bacteria in sterile, normal salt solution. Example: Staphylococcus Vaccine.

A *sero-bacterin* is a bacterin in which the bacterial cells are sensitized with an immune serum specific for the bacteria used. Both bacterins and sero-bacterins are used for the development of active immunity.

A *tuberculin* is a sterile solution, usually a glycerin suspension, of the products of growth or an extract of the tubercle bacillus.

**Storage.**—Unless otherwise indicated in the following monographs, the various bacterial biological products must be stored at a temperature between 2° and 10°C., preferably at the lower limit, and dispensed in the unopened glass containers in which they are placed by the manufacturers. They must be free from harmful substances detectable by animal inoculation.

They must all comply with the requirements of the National Institute of Health of the United States Public Health Service.

## ANTITOXINS

### DIPHTHERIA ANTITOXIN U.S.P. (ANTITOXINUM DIPHTHERICUM)

**Synonyms.**—Purified Antidiphtheric Serum, Concentrated Diphtheria Antitoxin, Refined Diphtheria Antitoxin, Antidiphtheric Globulins.

**Definition.**—Diphtheria Antitoxin is a sterile aqueous solution of antitoxic substances obtained from the blood serum or plasma of a healthy animal which has been immunized against diphtheria toxin.

**Preparation.**—The horse or other animal is first immunized against diphtheria toxin by injecting it with repeated doses of diphtheria toxin in increasing amounts over a period of from 3 to 6 months. During this time its body cells react to the stimulating influence of the toxin and produce antitoxin. The horse is then bled from the external jugular vein and the blood collected into sterile vessels containing sodium citrate solution and allowed to form sediment. The clear supernatant serum or plasma is then siphoned off and the antitoxin bearing globulins (pseudoglobulins) separated from the other constituents of the serum by precipitation with ammonium sulfate followed by dialysis for the removal of the sulfate. The pseudoglobulins are then dissolved in freshly distilled water. Sodium chloride and a preservative such as phenol (0.5 per cent.) or cresol (0.4 per cent.) are then added and the solution is filtered through a bacteria-excluding filter and placed in sterile glass containers.

**Potency.**—Diphtheria Antitoxin has a potency of not less than 500 antitoxic units per cc. The antitoxic unit shall be that of the standard Diphtheria Antitoxin distributed by the National Institute of Health of the U. S. Public Health Service.

**Labeling.**—The outside label of the package must carry the name “Diphtheria Antitoxin,” the minimum number of antitoxic units in the container, the manufacturer’s lot number of the Antitoxin, the name, address, and license number of the manufacturer, the genus of animal employed when other than the horse, and the date beyond which the minimum potency of the contents, as declared on the label, may not be maintained.

**Average Dose.**—By parenteral injection, Therapeutic, 20,000 units; prophylactic, 1000 units.

BIVALENT GAS GANGRENE ANTITOXIN U.S.P.  
(ANTITOXINUM GAS-GANGRÆNOSUM BIVALENS)

**Definition.**—A sterile solution of antitoxic substances obtained from the blood of healthy animals which have been immunized against *Clostridium perfringens* and *Clostridium septicum* toxins. Each package of this antitoxin shall contain not less than 10,000 antitoxic units of each of the component antitoxins.

**Use.**—In the prophylaxis and treatment of wound infections.

**Average Dose.**—Parenteral, therapeutic or prophylactic, the contents of one or more packages as the initial dose.

TRIVALENT GAS GANGRENE ANTITOXIN U.S.P.  
(ANTITOXINUM GAS-GANGRÆNOSUM TRIVALENS)

**Definition.**—A sterile solution of antitoxic substances obtained from the blood of healthy animals which have been immunized against the toxins of *Clostridium perfringens*, *Clostridium septicum* and *Clostridium œdematiens* (Novyi). Each package shall contain not less than 10,000 units of *Clostridium perfringens* and *Clostridium septicum* antitoxins and 1500 units of *Clostridium œdematiens* antitoxin.

**Use.**—In the treatment and prevention of wound infections.

**Average Dose.**—Parenteral, therapeutic or prophylactic, the contents of one or more packages as the initial dose.

PENTAVALENT GAS GANGRENE ANTITOXIN U.S.P.  
(ANTITOXINUM GAS-GANGRÆNOSUM PENTAVALENS)

**Definition.**—A sterile solution of antitoxic substances obtained from the blood of healthy animals which have been immunized against the toxins of *Clostridium perfringens*, *Clostridium septicum*, *Clostridium œdematiens* (Novyi), *Clostridium bifermentans* (Sordelli), and *Clostridium histolyticum*. Each package shall contain not less than 10,000 units each of *Clostridium perfringens* and *Clostridium septicum* antitoxins, 3000 units of *Clostridium histolyticum* antitoxin and 1500 units each of *Clostridium œdematiens* and *Clostridium bifermentans* antitoxins.

**Use.**—In the treatment or prevention of wound infections.

**Average Dose.**—Parenteral, therapeutic, or prophylactic, the contents of one or more packages as the initial dose.

## TETANUS ANTITOXIN U.S.P. (ANTITOXINUM TETANICUM)

**Synonyms.**—Purified Antitetanic Serum, Concentrated Tetanus Antitoxin. Refined Tetanus Antitoxin, Antitetanic Globulins.

**Definition.**—Tetanus Antitoxin is a sterile aqueous solution of antitoxic substances obtained from the blood serum or plasma of a healthy animal which has been immunized against tetanus toxin.

After the serum or plasma from the immunized animal has been collected, the antitoxin-bearing globulins are separated from the other constituents of the serum or plasma and dissolved in freshly distilled water. Sodium chloride and a preservative are then added and the solution is filtered through a bacteria excluding filter.

**Potency.**—Tetanus Antitoxin has a potency of not less than 400 antitoxic units per cc. The unit is the American Unit which is approximately twice the strength of the International Unit.

**Average Dose.**—By parenteral injection, therapeutic, 20,000 units; prophylactic, 1500 units.

TETANUS AND GAS GANGRENE ANTITOXINS U.S.P.  
(ANTITOXINA TETANICA ET GAS-GANGRÆNOSA)

**Definition.**—A sterile solution of antitoxic substances obtained from the blood of healthy animals which have been immunized against the toxins of *Clostridium tetani*, *Clostridium perfringens* and *Clostridium septicum*. Each package of the Antitoxins contains not less than 1500 units of tetanus antitoxin and not less than 2000 units of each of the other component antitoxins.

**Potency.**—Expressed in antitoxic units, the units being those of the Tetanus, Perfringens and Vibrio Septique antitoxins prescribed by the National Institute of Health of the U.S. Public Health Service.

**Use.**—In the prevention of gas gangrene and tetanus.

**Average Dose.**—Parenteral, prophylactic, the contents of one or more packages.

SCARLET FEVER STREPTOCOCCUS ANTITOXIN U.S.P. (ANTITOXINUM  
SCARLATINÆ STREPTOCOCCICUM)

**Synonyms.**—*Scarlet Fever Antitoxin*, Anti-Scarlet Fever Globulins, Concentrated- or Refined-Scarlet Fever Antitoxin.

**Definition.**—Scarlet Fever Antitoxin is a sterile aqueous solution of antitoxic substances obtained from the blood serum or plasma of a healthy animal which has been immunized against the toxin produced by the streptococcus regarded as causative of scarlet fever.

**Potency.**—Not less than 400 antitoxic units per cc.

**Production.**—After the serum or plasma from the immunized animal has been collected, the antitoxin bearing globulins are separated from the other constituents of the serum or plasma and dissolved in freshly distilled water. Sodium chloride and a preservative are then added and the solution is filtered through a bacteria-excluding filter.

**Storage.**—Scarlet Fever Antitoxin must be preserved at a temperature between 2° and 10°C., preferably at the lower limit. It must be dispensed in the unopened glass container in which it was placed by the manufacturer.

**Average Dose.**—Diagnostic, for aid in determining the nature of a rash (Schultz-Charlton Test) intracutaneous into erythrematous eruption, not to exceed 0.2 cc. Parenteral therapeutic, 6000 units; prophylactic, 2000 units.

## TOXOIDS

### DIPHTHERIA TOXOID U.S.P. (TOXOIDUM DIPHTHERICUM)

**Synonyms.**—Toxinum Diphthericum Detoxicatum, *Diphtheria Anatoxin*, *Anatoxin-Ramon*.

**Definition.**—Diphtheria Toxoid is a sterile aqueous solution of the products of growth of the diphtheria bacillus (*Corynebacterium diphtheriæ*) so modified by special treatment as to have lost the ability to cause toxic effects in guinea pigs but retaining the property of inducing active immunity.

The toxicity of the Diphtheria Toxoid shall be so low that 5 times the initial dose for the adult human does not cause either local or general symptoms of diphtheria poisoning in a guinea pig within 30 days after its injection into the animal.

The antigenic value shall be such that the initial dose for the human shall protect at least 80 per cent. of guinea pigs, 6 weeks after injection, against 5 minimum lethal doses each of diphtheria test toxin.

**Average Dose.**—Hypodermic, for active immunization, 1 cc. or 0.5 cc. to be repeated twice at intervals of approximately 3 weeks between injections.

A concentrated Diphtheria Toxoid is recognized by the U.S.P. known as **Alum Precipitated, Diphtheria Toxoid**. This is prepared by adding a sterile aqueous solution of alum to Diphtheria Toxoid, washing the resultant precipitate with physiological solution of NaCl, and resuspending it in physiological solution of NaCl to which a suitable preservative may be added. The average dose is the same as for the regular Diphtheria Toxoid but the dose is to be repeated only once with an interval of 4 to 6 weeks.

### TETANUS TOXOID U.S.P. (TOXOIDUM TETANICUM)

**Definition.**—A sterile solution of the products of growth of the tetanus bacillus (*Clostridium tetani*) so modified by special treatment as to have lost the ability to cause toxic effects in guinea pigs but retaining the property of inducing active immunity.

The toxicity of Tetanus Toxoid shall be so low that 5 cc. of the material does not cause any symptoms of tetanus in a guinea pig within a period of 21 days after its injection into the animal.

The antigenic value shall be such that 1 cc. of the material shall 6 weeks after injection protect at least 80 per cent. of guinea pigs from all symptoms of tetanus for a period of 10 days after the injection of 10 minimum lethal doses of tetanus test toxin into each animal.

The U.S.P. also recognizes a concentrated tetanus toxoid known as **Alum Precipitated Tetanus Toxoid**. The average dose is the same as for the regular Tetanus Toxoid but the dose is to be repeated once with an interval of 4 to 6 weeks.

**Average Dose.**—Hypodermic, for active immunization, 1 cc. or 0.5 cc. to be repeated twice at intervals of approximately 3 weeks between injections.

#### DIAGNOSTIC TOXINS

##### DIAGNOSTIC DIPHTHERIA TOXIN (TOXINUM DIPHThERICUM DIAGNOSTICUM)

**Synonym.**—*Schick Test Toxin, Diphtheria Toxin for the Shick Test.*

**Definition.**—A sterile solution of the toxic products of growth of the diphtheria bacillus (*Corynebacterium diphtheriæ*).

**Description.**—A transparent liquid containing  $\frac{1}{50}$  of the minimum lethal dose of diphtheria toxin in 0.1 cc.

**Average Dose.**—For determining susceptibility (Schick Test), intracutaneous, 0.1 cc. of the dilution, representing  $\frac{1}{50}$  of the minimum lethal dose.

The minimum lethal dose of this preparation is the smallest amount of toxin which, administered subcutaneously to a 250- to 280-Gm. guinea pig will cause the death of the animal within 96 hours after administration.

##### SCARLET FEVER STREPTOCOCCUS TOXIN U.S.P. (TOXINUM SCARLATINÆ STREPTOCOCCICUM)

**Synonym.**—*Dick Test Toxin.*

**Definition.**—A sterile solution in a medium containing not more than 1 per cent. of peptone but no meat extractive, of certain products including a soluble toxin, resulting from the growth in the broth of suitable strains of hemolytic streptococci (*Streptococcus scarlatinae*).

**Potency.**—The potency of this toxin shall be expressed in terms of the skin test dose. The skin test dose is the smallest quantity of Scarlet Fever Streptococcus Toxin which, injected intracutaneously, will induce positive reactions in any person susceptible to scarlet fever and negative reactions in any person immune to scarlet fever.

**Average Dose.**—Diagnostic, for determining susceptibility (Dick test), intracutaneous, 0.1 cc. of the dilution, representing one skin test dose. Prophylactic, hypodermic injection for active immunization, graded doses until a negative Dick test is obtained. For active immunization this toxin is packaged in units of five 1 cc. vials containing, respectively, 650, 2,500, 10,000, 30,000 and 100,000–120,000 skin test doses per cc. and in single vial packages containing 100,000–120,000 skin test doses.

#### SERA

##### ANTIMENINGOCOCCIC SERUM N.F. (SERUM ANTIMENINGOCOCCICUM)

**Synonyms.**—*Antimeningococcus Serum, Meningococcus Serum, Meningitis Serum.*

**Definition.**—Antimeningococcic Serum is obtained from the blood of an animal immunized with cultures of the several types of meningococci (*Neisseria intracellularis*) which prevail in the United States.

**Use.**—In cerebrospinal meningitis.

**Average Dose.**—Therapeutic, by parenteral injection (into the meningeal space of the spinal canal), 20 cc.

ANTIPNEUMOCOCCIC SERUM-TYPE SPECIFIC N.F. (SERUM  
ANTIPNEUMOCOCCICUM)

**Synonyms.**—*Pneumonia Serum, Antipneumococcus Serum.*

**Definition.**—Antipneumococcic Serum is obtained from the blood of an animal which has been immunized with cultures of a pneumococcus (*Diplococcus pneumoniae*) of one of the types for which a serum has been prepared and which has been standardized or released by the National Institute of Health of the U.S.P.H.S. and complies with the requirements of that agency of the Government.

**Use.**—In the early stage of pneumonia infection.

**Average Dose.**—Therapeutic, by parenteral injection, from 20,000 to 100,000 units. Type XIV Antipneumococcic Serum produced by immunization of the horse should not be administered to persons of blood group "A."

HUMAN MEASLES IMMUNE SERUM N.F. (SERUM IMMUNE MORBILLOSI  
HUMANUM)

**Synonym.**—*Measles Convalescent Serum.*

**Definition.**—Sterile serum obtained from the blood of a healthy human (*Homo sapiens* L.) who survived an attack of measles.

**Average Dose.**—Parenteral, therapeutic, 20 cc.; prophylactic, 10 cc.

HUMAN SCARLET FEVER IMMUNE SERUM N.F. (SERUM IMMUNE  
SCARLATINÆ HUMANUM)

**Synonym.**—*Scarlet Fever Convalescent Serum.*

**Definition.**—A sterile serum obtained from the blood of a healthy human (*Homo sapiens* L.) who has survived an attack of scarlet fever.

**Average Dose.**—Parenteral, therapeutic, 20 cc.; prophylactic, 10 cc.

VACCINES

SMALLPOX VACCINE U.S.P. (VACCINUM VARIOLÆ)

**Synonyms.**—Virus Vaccinicum, Glycerinated Vaccine Virus, Jennerian Vaccine, Antismallpox Vaccine.

**Definition.**—Smallpox Vaccine consists of a glycerinated suspension of the vesicles of vaccinia or cowpox which has been obtained from healthy vaccinated animals of the bovine family. The vesicles must be removed and the vaccine must be prepared under aseptic conditions.

The vesicles must be removed from the animal at the time of suitable development, thoroughly triturated and made into a smooth suspension with an



aqueous solution of glycerine. This solution must not be acid to bromcresol purple pH indicator and not distinctly alkaline to phenol red pH indicator.

**Storage.**—The product should be preserved and dispensed in hermetically sealed, capillary glass tubes. It must be kept at a very low temperature, preferably below 0°C. and never above 5°C. It loses potency rapidly at higher temperatures.

**Use.**—As a prophylactic, by vaccination, against smallpox.

#### RABIES VACCINE U.S.P. (VACCINUM RABIES)

**Synonyms.**—Antirabic Virus, Antirabic Vaccine, Pasteur Treatment, Pasteur Prophylactic.

**Definition.**—Rabies Vaccine is an uncontaminated suspension of the attenuated, diluted, dried or dead, fixed virus of rabies. The virus is obtained from the tissue of the central nervous system of an animal suffering from fixed virus rabies infection.

**Preparation.**—The rabies virus, which must come from animals which are healthy except for rabies infection, is made non-virulent by passing it through a long series of rabbits and treated in various ways to decrease its infection power or to destroy it. The more important methods of treating the virus before it is inoculated are discussed in works on Immunology and Bacteriology. They include the drying of the spinal cord (Pasteur), emulsification of brain or spinal cord with phenol (Semple), dilution of virus (Högyes) or dialyzing a 1 per cent. suspension of brain tissue (Cummings).

**Storage.**—Preserve at a temperature between 2° and 10°C., preferably at the lower limit. It must be dispensed in the unopened glass container of the manufacturer.

**Use.**—As a prophylactic for persons bitten by rabid animals, administered before the symptoms of the disease develop.

**Average Dose.**—Hypodermic, for active immunization, the contents of one container, to be repeated at proper intervals.

#### TYPHOID VACCINE U.S.P. (VACCINUM TYPHOSUM)

**Synonyms.**—Typhoid Prophylactic, Enteric Vaccine.

**Definition.**—A sterile suspension in isotonic sodium chloride solution or other suitable diluent of killed typhoid bacilli (*Eberthella typhosa*), of a strain selected for high antigenic efficiency. The vaccine shall contain in each cc., at least, 1 billion typhoid organisms.

**Average Dose.**—Hypodermic, for active immunization, 0.5 cc. and 1 cc., the latter dose to be repeated once.

#### TYPHOID AND PARATYPHOID VACCINES U.S.P. (VACCINA TYPHOSA ET PARATYPHOSA)

**Synonyms.**—Typhoid Combined Vaccine, Typhoid-Paratyphoid Combined Vaccine, Typhoid Mixed Vaccine Prophylactic, Typhoid Paratyphoid Prophylactic, Mixed Enteric Vaccine.

**Definition.**—A suspension in isotonic solution of sodium chloride or other suitable diluent of killed typhoid bacilli (*Eberthella typhosa*) of a strain selected for high antigenic efficiency and killed paratyphoid "A" bacilli (*Salmonella paratyphi*) and killed paratyphoid "B" bacilli (*Salmonella schottmülleri*).

The Vaccine shall contain in 1 cc., at least, 1 billion typhoid organisms and at least 250 million of each of the paratyphoid organisms.

**Average Dose.**—Hypodermic, for active immunization, 0.5 cc. and 1 cc., the latter dose to be repeated once.

#### EPIDEMIC TYPHUS VACCINE U.S.P. (VACCINUM TYPHUSUM EPIDEMICUM)

**Synonym.**—*Typhus Vaccine*.

**Definition.**—A sterile suspension of the killed rickettsial organism of a strain or strains of epidemic typhus rickettsiæ selected for antigenic efficiency. The rickettsial organisms are obtained by culturing in the yolk sac membrane of the developing embryo of the domestic fowl (*Gallus domesticus* Temminck).

**Use.**—For immunization against Typhus fever.

**Average Dose.**—Hypodermic, for active immunization, 1.0 cc., to be repeated once or twice with 7 to 10 day intervals. When real danger of infection prevails, a booster dose every six months is recommended.

#### YELLOW FEVER VACCINE U.S.P. (VACCINUM FEBRIS FLAVÆ)

**Definition.**—A living culture of an attenuated strain of yellow fever virus, selected for high antigenic activity and safety.

**Preparation.**—Yellow Fever Vaccine is prepared by culturing the virus of yellow fever in the living embryo of the domestic fowl (*Gallus domesticus* Temminck). The resultant culture is processed, distributed in suitable quantities into ampuls, and dried from the frozen state. The ampuls are then filled with dry nitrogen and hermetically sealed. It is not permitted to contain human serum. It is rehydrated before use.

**Description.**—It occurs as a slightly dull, light orange colored, flaky or crust-like, desiccated mass.

**Preservation and Storage.**—It must be preserved in nitrogen-filled, hermetically sealed ampuls at a temperature preferably below 0° but never above 5°C. throughout the dating period. During its storage by the manufacturer, prior to dating, it should be stored at a temperature of -20° but never above -5°C.

**Average Dose.**—Of the rehydrated and diluted vaccine, subcutaneous, for active immunization, 0.5 cc.

#### PLAGUE VACCINE U.S.P. (VACCINUM PESTIS)

**Definition.**—A sterile suspension of killed plague bacilli (*Pasteurella pestis*), of a strain selected for high antigenic activity in isotonic solution of sodium chloride or other suitable diluent.

Plague Vaccine shall contain in each cc. at least 2,000 million plague organisms.

**Use.**—For the prevention of bubonic plague or “black death,” a disease which attacks rats and some other animals. The infection is communicated to human beings by fleas or direct contact.

**Average Dose.**—Hypodermic, for active immunization, 0.5 cc. and 1 cc., with a 7 to 10 days’ interval, the latter dose preferably to be repeated once.

### TUBERCULINS

#### OLD TUBERCULIN U.S.P. (TUBERCULINUM PRISTINUM)

**Synonyms.**—*Tuberculin-Koch, Crude Tuberculin, Concentrated Tuberculin.*

**Definition.**—Old Tuberculin is a sterile solution in a special liquid culture medium of the soluble products of growth of the tubercle bacillus (*Mycobacterium tuberculosis*) and should contain about 50 per cent of glycerin.

**Use.**—For the diagnosis and treatment of tuberculosis.

**Average Dose.**—Diagnostic, intracutaneous—0.000,01 cc. to 0.001 cc. Therapeutic, subcutaneous—0.000,000,01 cc. to 0.000,001 cc.

#### PURIFIED PROTEIN DERIVATIVE OF TUBERCULIN U.S.P. (TUBERCULINI DERIVATINUM PROTEINICUM PURIFICATUM)

**Synonym.**—*Tuberculin P.P.D.*

**Definition.**—A sterile soluble product of the growth of the tubercle bacillus (*Mycobacterium tuberculosis*) prepared in a special liquid medium free from protein.

**Description.**—An amorphous whitish powder readily soluble in water. Like Old Tuberculin, it must be capable of effecting a general and local response in tuberculous guinea pigs.

**Use.**—In the diagnosis of tuberculosis.

**Average Dose.**—Diagnostic, 0.00002 mg. or 0.005 mg.

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## CHAPTER IV

### MICROANALYTICAL METHODS

Microanalysis may be defined as that method of laboratory procedure which involves the use, in analytical work, of a microscope, simple, compound, petrographical or any other type. Microanalytical methods, which are largely qualitative, make it possible to identify plant and animal materials by certain diagnostic histological characters and to confirm the identification of material by certain physical constants. Quantitative microanalytical methods are also of considerable value.

The early microanalyst's field of activity was restricted to the identification of plant ingredients. For that reason he needed chiefly a strong foundation in botanical subjects, particularly those relating to plant anatomy and histological structures. The microscopy of vegetable foods and drugs, therefore, became his largest field of activity. This has broadened to include animal materials. More recently microchemical technique and the application of optical-crystallographic methods to the identification of small quantities of crystalline material have become part of the microanalyst's work.

For the microscopical identification of plant or animal ingredients in powdered material, the microanalyst must be prepared to detect differences in structure readily and to evaluate their importance properly. The eye must be trained to recognize diagnostic structures that serve to differentiate powdered stem materials from flower powder and roots from stems, the presence or absence of characteristic crystalline material, variation in the shape and size of characteristic plant hairs, abundance and shape of sclerenchyma elements, the characteristic structure of bone and meat fragments, and the reaction of various cell structures to microchemical reagents.

A microscopical study of plant and animal structures furnishes the basis upon which to build the fund of specialized information obtained by practical experience. As the field of study enlarges, the microanalyst rapidly accumulates a large working acquaintance with many substances in the powdered condition, a first-hand knowledge of which enables him at once to determine the presence or absence of a certain ingredient in a mixture.

The critical microscopical study of any powdered material implies a thorough study by the analyst of the various parts of the ingredients which he has been called upon to identify. For instance, in the case of a product consisting of powdered flower and stem materials, it is reasonable to suppose that the microanalyst has first studied the various parts of the flower, including the stem material, in the whole as well as in the powdered condition. Freehand sections of the various parts are useful in showing the proper relationship of the different

structures. It is quite as advantageous, however, to separate the parts of the flower, for example, and examine them in the powdered condition. In this manner the different structures are broken up into sections and fragments of sections, quite unlike any found in freehand sections made with a razor. A microscopical study of these powdered parts from any particular ingredient makes it possible to recognize them in a finely ground commercial product. This procedure, varying to meet special conditions, is valuable in the initial study of any product.

Mixing the unknown sample is a prerequisite of a microscopical examination. This is best done by spreading the sample upon a sheet of clean white paper and mixing the powder with a spatula or rolling it back and forth. After thorough mixing, a composite portion is drawn from various parts of the sample. It is desirable to make the first examination in water, to make certain that foreign starches are absent. A drop of iodine in potassium iodide solution may be drawn under the cover glass for subsequent confirmation of the presence of starchy material. For further examination a small portion of the powder should be mounted in chloral hydrate solution and gently warmed. This solution serves to dissolve any starch that may be present, and clears the tissues generally.

A nest of sieves, ranging from 30-mesh to 100-mesh, and a dissecting microscope, are also valuable aids in general microanalytical work. Sifting a powdered sample through a sieve often makes it possible to pick out larger fragments, which may be identified by their general appearance or sectioned for more detailed study. The coarse material left on the sieve can be advantageously studied with a dissecting microscope provided with a transparent glass stage and lenses giving a magnification of approximately 8 and 16.

**Quantitative Microanalysis.**—Although surprisingly accurate and trustworthy results may be obtained by the quantitative microanalysis of certain classes of products, this branch of microanalytical work has its limitations and its use may at times be difficult. Experience is necessary for the successful manipulation of these methods. Carefully prepared standard reference samples containing known amounts of the suspected ingredient and as nearly identical as possible in fineness of powder (slightly finer if anything) with the product under examination are essential. A thorough mixing of the standard reference samples is also an important precaution. Various workers have used different methods of attack. Some have used diluents, while others have used certain specific diagnostic tissue elements as criteria. Every problem in quantitative microanalysis must be considered on its own merits rather than on general conclusions applicable in all cases.

*Method for Determination of Percentage of Powdered Daisy Flowers in  
Insect Powder*

The equipment essential for carrying out this method consists of a compound microscope equipped with ocular and objective and giving a magnification of 90 to 120 diameters, an analytical balance, ruled microscopic slides similar to

that shown in Fig. 517, dissecting needle, small camel's hair brush,  $\frac{1}{8}$  inch square cover glasses, and fine mesh sieves.

Standard reference samples are first prepared by grinding together known amounts of Daisy (*Chrysanthemum Leucanthemum*) flower heads and Pyrethri Flores. The resulting powder should be reduced to the same degree of fineness as that of the sample to be determined. Both should be thoroughly mixed and passed through number 60 to 80 mesh sieves before further procedure.

Weigh out 4 lots of 2 mg. each of the reference sample. Transfer each to the ruled microscopic slides by means of a camel's hair pencil, add sufficient chloral hydrate solution and apply cover glass. It is important that all of the material on each slide be distributed as evenly as possible beneath cover glass and none outside of cover glass.

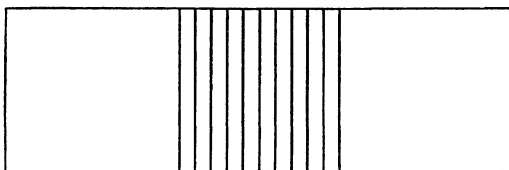


FIG. 517.—Ruled microscopic slide, useful in making certain quantitative microscopical counts.

Calculate the number of characteristic deep red amorphous masses of the Daisy achene in each mount by moving the slide slowly in the direction parallel to the rulings and by counting particles between each two ruled lines until the entire mount is covered. Determine average for 2 mg.

Weigh out 4 lots of 2 mg. each of the sample to be determined; transfer to ruled microscopic slides and proceed with the same technique as for the reference samples. Calculate the average as above. Compare counts which will give the necessary ratio for determining the percentage of Daisy flowers present.

Thus, if the average for 2 mg. of a reference sample containing 50 per cent. Daisy flowers was 60 and the average for the 2 mg. sample of the material under investigation was 30, then

$$\begin{aligned} 30:(60 \times 2)120::x:100 \\ 120x = 3000 \\ x = 25 \text{ per cent.} \end{aligned}$$

This same method may be employed with but slight modifications in the determination of Insect Flower stems and Turmeric admixture of Insect Powder, as well as in the following additional determinations: Cacao shells in Cocoa and Clove stems in powdered Clove.

In determining the percentage of Cacao shells in Cocoa the mounts may be made either in Ruthenium Red and Lead Acetate solution and the mucilage cells counted or in Phloroglucin-HCl and the stone cells counted.

In determining the percentage of Clove stems in Powdered Clove, the



mounts are made in Phloroglucin-HCl and the stone cells counted. In determining the percentage of Insect Flower stems, the mounts are made in Phloroglucin and Hydrochloric acid reagent and the fragments of fibrovascular tissues counted, whereas Turmeric mounts are made in water and the masses of altered starch as well as the unaltered starch grains are counted.

### *The Lycopodium Method of Wallis*

This method was devised by T. E. Wallis of the Pharmaceutical Society of Great Britain and is published in detail in the *Analyst*, 1916, pp. 357-374. It is based upon the fact that Lycopodium spores are exceptionally uniform in size, so that a definite number of spores represents a particular weight of Lycopodium. Wallis found there were, on the average, 94,000 spores per milligram of Lycopodium. If lycopodium be mixed with a definite proportion of another substance, it is possible to find readily how much of the second substance has been examined microscopically in admixture with the spores.

If, according to Wallis, the substance admixed with the lycopodium contains starch, stone cells, hairs, pollen grains, etc. which are characteristic, it is possible to compute quickly the number of such characteristic elements per mg. present in the sample. A standard figure is thus obtained which represents any such pure material.

The suspending agent used is either olive oil, a mixture of olive oil and castor oil or mucilage of tragacanth depending upon the character of the materials. The standard powders are carefully mixed together by trituration in a mortar.

In preparing a suspension, the lycopodium and the powder to be examined must be intimately mixed with the suspending agent. This may be accomplished by using a spatula and plate and working up a small portion of the mixed materials with the oil or mucilage into a thin paste, transferring this to a weighing bottle, mixing the residue with more of the suspending medium and repeating the operation until all of the powder has been removed. The suspension is made up to such a volume as to give about 10 to 20 lycopodium spores in each field of view, the total volume being about 20 cc.

A drop of sufficient size of the suspended sample to fill up the space beneath the cover glass is transferred to the micro-slide and the lycopodium spores and diagnostic element in the powder counted separately in each of 10 selected fields. At least two sets of counts are made using two mounts, and the mean average of these gives a ratio from which the standard figure based upon a definite diagnostic element in the powder may readily be computed. Having determined the standard figure for a given powder, it is a comparatively easy matter to determine the percentage of that powder in a mixture. The same technique is used. The mixture is substituted for the powder and the result based upon the proportions of diagnostic element in the powder and mixture. For further details and applications of this method consult "Analytical Microscopy" by Wallis, 1923, pp. 127-137.

*Determination of the Number of Starch Grains per mg. of Corn Starch  
(Wallis Method)*

Wallis used the following method: 200 mg. of lycopodium is mixed with 100 mg. of corn starch and 20 cc. of olive oil. Prepare four slides by mounting drops of the suspension and count the number of lycopodium spores and corn starch grains in 10 selected fields of each slide, record the number of spores and corn starch grains and take the average of each. Wallis found an average of 450 grains for every 100 lycopodium spores.

Hence there were  $450 \times 94,000$  (av. no. of lycopodium spores per mg. of lycopodium)  $\div 100$  starch grains for every mg. of lycopodium. Since this weight of lycopodium was mixed with 0.5 mg. of starch, there are  $2 \times 450 \times 94,000 \div 100 = 846,000$  starch grains per mg. of air-dried starch. Allowing for 13.4 per cent of moisture, there are  $846,000 \times 100 \div 86.6 = 977,000$  grains per mg. of corn starch dried at 100°C.

*Preparation of the Suspensions.*—In order that a small amount of the materials may accurately represent the whole, the weighed amounts of lycopodium and starch or other standard powder must first be thoroughly mixed by trituration in a mortar. Then the mixed material is placed on a porcelain plate, a little of the suspending agent added and worked up into a thin paste by means of a spatula. This is transferred to a stoppered cylindrical weighing bottle. The residue on the plate is similarly mixed with more of the suspending medium and transferred to the bottle and the operation repeated until the whole of the powder has been removed. The suspension is made up to such a volume as to give 10 to 20 lycopodium spores in each field of view when a drop is mounted and examined with a 4 mm. objective.

Before mounting the drop of suspension, the latter must be shaken vigorously. The size of the drop should be such as to just fill up the space beneath the cover glass. See also Method of Proper and Youngken, Jr., *Jour. Amer. Pharm. Assoc.*, 37 (1948), 166.

**Microchemical Tests.**—Microchemical tests are invaluable in microanalytical work and often serve to identify rapidly and accurately small quantities of material. Many textbooks on microchemistry describe the methods to be followed. Caution is necessary to interpret correctly results on small quantities. Chemical crystalline precipitates of a certain definite habit are often misleading and, unless care and judgment is exercised, may lead to erroneous conclusions. Although the results of microchemical tests furnish valuable clues to the identity of a substance, unfortunately, they tell only half the story. For instance, they may show the presence of two metals in an admixture, but they can give no indication as to the combination of the metals with any acid radicals that might be identified. Such tests are purely qualitative and somewhat limited.

A number of these tests are included under various drug monographs on preceding pages of this text. Many additional ones will be found in works cited in the bibliography of this chapter, some of the more recent ones appearing in scattered numbers of the *American Journal of Pharmacy* for 1928 and 1929.

**Optical-crystallographic Methods.**—Small quantities of crystalline material, which cannot be wasted in making many qualitative tests, must often be identified. An examination of this material mounted in a suitable oily liquid soon establishes its identity. A microscope equipped with nicol prisms is necessary

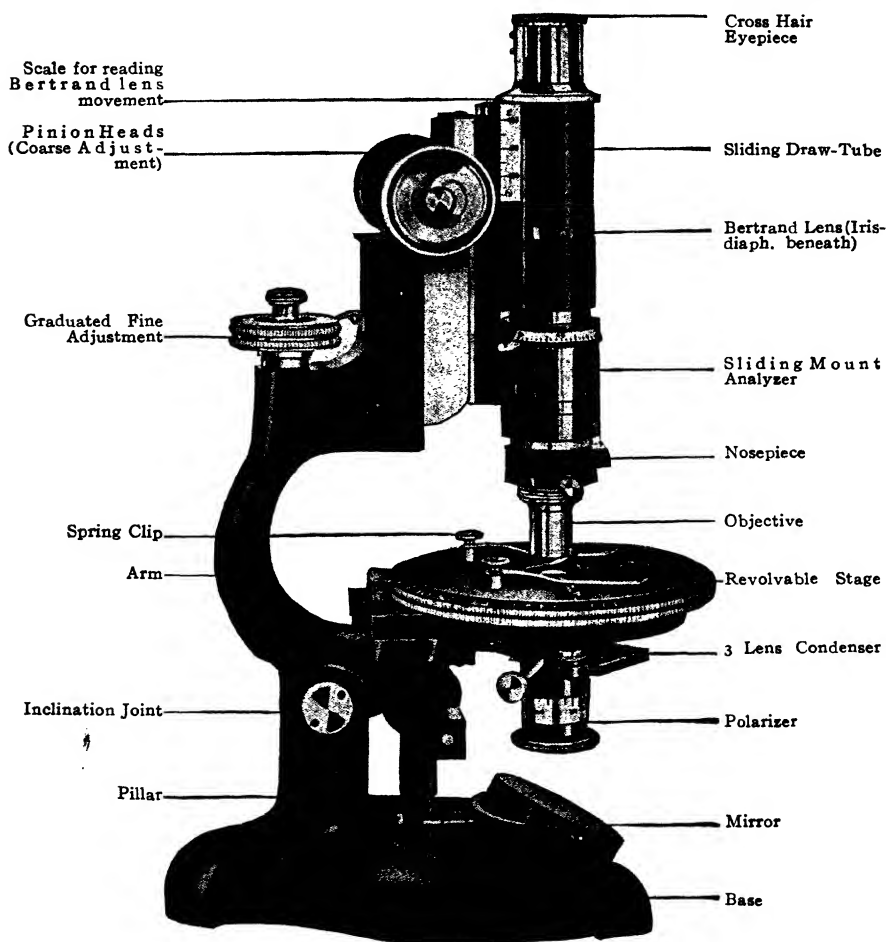


FIG. 518.—Petrographic microscope.

for this examination and a 4-millimeter, an 8-millimeter, and a 16-millimeter objective are usually the only lenses required. The other accessories furnished with a petrographic microscope are useful but not absolutely necessary in establishing the identity of crystalline material. The procedure followed in identifying a crystalline substance is the same as that used by petrographers in the identification of rock fragments. The most important optical constants which serve to identify a product with certainty are the refractive indices. These are determined by immersing the crystalline material in oily liquids of

known refractive index. The value of the index of refraction of each liquid is first determined by means of a refractometer. For most identification purposes, the liquids used differ in index only by two units in the second decimal place, that is, 1.48, 1.50, or by five units, that is, 1.485, 1.490. The refractive indices of a crystalline substance vary in number, depending upon the system in which the substance crystallizes. In crystals of the triclinic, monoclinic, and orthorhombic systems, three indices can be determined, the smallest being designated  $\alpha$ , the intermediate  $\beta$ , and the largest  $\gamma$ . In those belonging to the hexagonal, tetragonal, and trigonal systems, two indices can be determined,  $\omega$  and  $\epsilon$ . Crystals belonging to the cubic system give but one index, indicated as  $n$ .

The determination of the refractive indices of the substance is based on matching the refractive index of a crystalline fragment oriented in a certain position against that of the oily liquid which has been predetermined on a refractometer. The fragment of material, immersed in the liquid on a slide, is examined under the microscope with the polarizer (lower nicol) in place. Attention is then paid to the direction in which the band of light surrounding the fragment moves when the microscope tube is raised. If it passes into the crystal the refractive index in the crystallographic direction lying parallel to the plane of the nicol is higher than that of the crystal. In other words, when the microscope tube is raised, the band of light passes toward the medium (either liquid or crystal) which has the higher index of refraction. When the crystal fragment (in any particular position) and the immersion liquid are of the same refractive index, the crystal fragment disappears completely in the liquid. A large number of fragments are examined until the analyst is convinced that the minimum, intermediate, and maximum indices in the monoclinic, triclinic, and rhombic systems have been determined. In the case of the cubic system only one index can be determined, and in the case of the hexagonal, tetragonal, and trigonal systems, two indices can be determined. The examination of any crystalline material, then, is based on the fact that it has significant refractive indices which are important in establishing its identity.

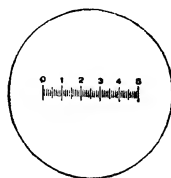


FIG. 519.—Ocular micrometer.

### MICROMETRY

The unit of length used in microscopic measurement is the *micron* ( $\mu$ ) which is one-thousandth part of a millimeter (0.001 mm.) or one twenty-five thousandth part of an inch.

In measuring microscopic objects it is necessary to make use of a micrometer of some kind. That pretty generally used is the *ocular micrometer* (Fig. 519). It is a circle of glass suitable for insertion within the ocular with a scale etched on its surface. The scale is divided to tenths of a millimeter (0.1 mm.) or the entire surface of the glass may be etched with squares (0.1 mm.), the *net micrometer*.

## STANDARDIZATION OF OCULAR MICROMETER

The value of each division of the *ocular micrometer scale* must be ascertained for each optical combination (ocular, objective, and tube length) by the aid of a stage micrometer.

The *stage micrometer* (Fig. 520) is a slide with a scale engraved on it divided to hundredths of a millimeter (0.01 mm.) and in most cases, also, to tenths of a millimeter (0.1 mm.), every tenth line being made longer than intervening ones, to facilitate counting.

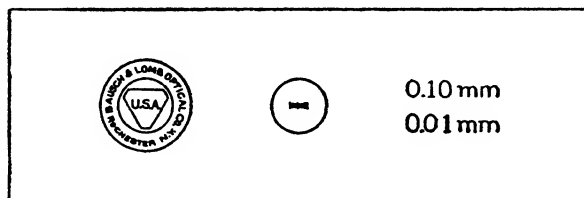


FIG. 520.—Stage micrometer used to standardize the ocular micrometer. The mm. readings etched on this micrometer indicate the width of the larger and smaller spaces of the stage micrometer scale seen in the center of the stage micrometer.

## METHOD:

1. Insert the ocular micrometer within the tube of the ocular by placing it on the diaphragm of the ocular, and adjust the stage micrometer by placing it on the stage of the microscope.
2. Focus the scale of the stage micrometer accurately so that the lines of the two micrometers will appear in the same plane. Make the lines on the two micrometers parallel each other. This can often be done by turning the ocular to the right or left, while looking into the microscope.
3. Make two of the lines of the ocular micrometer coincide with two on the stage micrometer by gently adjusting the stage micrometer with the left hand and the ocular carrying the ocular micrometer with the right hand. It is advisable to have the extreme left line on each scale coinciding and to note the lines farthest to the right which coincide. Count the number of included divisions.
4. Note the known value for each division of the stage micrometer scale which may either be etched on the stage micrometer or indicated on a label found pasted upon it. If the value indicated is 0.01 mm. ( $\frac{1}{100}$  mm.), then each division of the stage micrometer scale has a value of 10 microns; if 0.1 mm. ( $\frac{1}{10}$  mm.), 100 microns.
5. Multiply the number of included divisions of the stage micrometer scale by the value in microns given for each division and divide the result by the number of included divisions of the ocular micrometer scale. The quotient represents the value of each division of the ocular micrometer scale.
6. Note the optical combination (number of ocular, objective and tube length) used and keep a record of it with the calculated micrometer value. Repeat for each of the combinations.

To measure an object by this method, read off the number of divisions it occupies of the ocular micrometer scale, and express the result in microns by looking up the recorded value for the optical combination used.

#### VEIN ISLETS AND VEIN ISLET NUMBERS

Vein islets are divisions of green leaf tissue formed by the ultimate divisions of the conducting strands of vascular bundles which either completely or partially surround areas of the chlorenchyma. The islets increase in size as the leaf matures, the full grown leaf showing a constancy in vein islet number.

The determination of a vein islet number of a given leaf is made as follows; Pieces of mature leaf blade approximately 4 mm. square are cut from the apex, center, margin and base, cleared by gently warming in chloral hydrate solution, mounted in chloral hydrate solution, applying coverslip, and examined under a compound microscope having a 10× ocular and a 16 mm. objective. The area of the vein islet is determined by counting the number of vein islets within the field of vision. The number of vein islets within the field divided by the area of the field, in millimeters, gives the average area of the vein islet. Now, the optical combination of 10× ocular and 16 mm. objective gives a field of vision whose area is 1.96 sq. millimeters. This is close enough to the whole number 2, so that the Vein Islet Number can be easily calculated. Accurate determinations can only be made by counting the number of vein islets in all four positions of the leaf blade (apex, center, margin and base) of 5 different leaves, determining the vein islet number for each position, adding these and dividing by 5.

#### STOMATAL INDEX

The significance of the number of stomata per unit area of leaf was investigated by Timmerman [*Pharm. J.* 118(1927), 241]. Salisbury showed that a high correlation coefficient exists between the number of stomata and the number of epidermal cells per unit area of leaf surface of a given species. He proposed the following formula for the calculation of the stomatal index:

$$I = \frac{S}{S + E} \times 100$$

where  $S$  is the number of stomata per unit area and  $E$  is the number of ordinary epidermal cells in the same unit area. The stomatal index expresses the percentage proportions of the ultimate divisions of the dermatogens of the leaf that have been converted into stomata.

The equipment needed in making determinations of the stomatal index are a compound microscope equipped with a 10× ocular and a 4 mm. objective, a Whipple ocular micrometer, microslides and cover glasses.

**Method.**—Gently heat the leaves, if dry or if the epidermis is not readily detachable, in a solution of potassium hydroxide or of chloral hydrate, the percentage strength of which depends upon the texture of the leaf, varying from 2 to 2.5 per cent for membranous leaves to 5 or 10 per cent. for the coriaceous leaves of xerophytes. Strip off a portion of the epidermis and mount in

dilute glycerin or water. Count the number of stomata and the number of ordinary epidermal cells within the square millimeter of the Whipple micrometer, recording separately. Repeat on from 5 to 6 adjacent fields, and determine the average stomatal number and average number of ordinary epidermal cells. Determine the stomatal index by the formula of Salisbury.

#### PALISADE RATIO

The term "palisade ratio" was introduced by two British pharmacognosists, T. E. Wallis and T. Dewar, in 1933, in their paper on the comparative anatomy of species of *Barosma* (*Quart. J. Pharm. and Pharmacol.*, 6 (1933) 347). It represents a figure obtained by counting the total number of palisade cells beneath four upper epidermal cells and dividing the number by four.

As early as 1925, Zornig and Weiss, in a paper dealing with an anatomical description of leaves of the *Compositæ* (*Arch. Pharm. Berl.* 263(1925) 462), stated that the average number of palisade cells beneath an upper epidermal cell was of diagnostic value, also that the number of palisade cells per unit area increased successively from the base of the leaf to the apex, but that since there was a corresponding diminution in the area of the epidermal cells, the ratio remained almost constant.

Wallis and Forsdike (*Quart. J. Pharm. and Pharmacol.* 11 (1938) 700), in their investigation of the palisade ratio of *Atropa Belladonna*, *Scopolia carniolica* and *Solanum nigrum*, found that the palisade ratio did not change with the age of the leaf, the habitat of the plant, or from year to year within either of these species. Dewar has found the palisade ratio useful in differentiating between the leaves of some species of *Digitalis*, and Feinstein and Slama have found it useful in distinguishing leaves of *Atropa Belladonna* from *Datura Stramonium*, *Digitalis purpurea* and *Hyoscyamus niger*.

E. George (*Quart. J. Pharm. and Pharmacol.*, 16(1943) 227) determined the palisade ratio ranges for the upper and lower epidermises of Alexandria and Tinnevely Senna leaflets. He showed that the lower epidermis of *Cassia acutifolia* and the upper epidermis of *C. angustifolia* both have palisade ratios very near 7.5, that the upper epidermis of *C. acutifolia* has a palisade ratio of 9.5 and the lower epidermis of *C. angustifolia* has a palisade ratio of 5.0, and that the identity of a powder of either species of Senna can be established from the mean of 20 to 30 palisade ratio determinations on epidermal fragments, a value above 7.5 indicating *Cassia acutifolia* and a value below, *Cassia angustifolia*.

**Method.**—With a sharp knife or scalpel cut pieces 2 to 3 mm. square from the apex, margin, center and base of the leaf blade. Transfer these segments to test tubes containing a clearing solution consisting of 50 Gm. of chloral hydrate dissolved in 20 cc. of water and boil on the water bath for 15 minutes. Remove the leaf segments from the test tubes by means of a camel's hair pencil and mount in Berlese Mountant modified\* or in some other suitable clearing

\* Berlese Mountant modified is prepared by dissolving 5 Gm. dextrose in 10 cc. distilled water to which 8 Gm. gum arabic is added, then add 74 Gm. chloral hydrate, and finally, 3 cc. acetic acid.

solution, apply cover slip and examine under the microscope having a magnification of about 450 diameters. Examine and determine the palisade ratio by counting the number of palisade cells under 4 contiguous epidermal cells in each of 5 fields of 5 pieces cut from the apex, center, margin and base. Record the average palisade ratio for each of these locations. Add the average location palisade ratios and divide by 4, the result being the palisade ratio for the species. Caution must be observed not to count any palisade cell lying more than half outside of an epidermal cell.

### EXAMINATION OF POWDERED DESICCATED ENDOCRINE GLANDS

This work is of a fascinating yet highly technical character. It should, however, be attempted only by those who possess a practical laboratory knowledge of animal histology including staining technique. The student should first familiarize himself with teased-out tissues and stained sections of organs of animals and especially with the histological features of such endocrine glands as he may desire to study in powdered form.

It is obviously not the province of a text of applied character and scope, like this, to attempt to cover the ground of preliminary instruction in animal histology essential to the proper comprehension and prosecution of the problems involved in this field. Sufficient information, however, has been provided in this Chapter and in Chapter II which, with the additional perusal of standard texts on animal histology and histological technique, should give the student a good start in this, the newest field of pharmacognosy. There are a number of excellent works on animal histology such as the text books by J. L. Bremer and Alex. Maximow and W. Bloom, and on histological technique such as the texts of C. E. McClung et al., H. M. Carleton and Lee's "Vade Mecum."

**Preparation of Materials.**—In preparing the powdered glands for examination, the following selected list of stains and reagents are recommended as a basis for work.

- |   |   |
|---|---|
| 1. Acid fuchsin sol. (1%)                     | 12. Chromic acid sol. (10%)                     |
| 2. Aqueous eosin sol. (1%)                    | 13. Heidenhain's hematoxylin                    |
| 3. Alcoholic eosin sol. (1%)                  | 14. Mann's stain                                |
| 4. Methylene blue sol. (1%)                   | 15. Weigert's hematoxylin sol.                  |
| 5. Eosin and methylene blue sol. (1% of each) | 16. Weigert's borax-ferricyanide differentiator |
| 6. Borrel's methylene blue sol.               | 17. Weigert's copper acetate sol.               |
| 7. Delafield's hematoxylin                    | 18. Iodine T.S.                                 |
| 8. Mallory's connective tissue stain          | 19. Picric acid sol. (1% aqueous)               |
| 9. Phosphotungstic acid sol. (1%)             | 20. Ammonium picrate sol.                       |
| 10. Osmic acid sol. (1% and 0.5%)             | 21. Silver nitrate sol. (1% and 3%)             |
| 11. Alcohol in increasing percentages         | 22. Gold chloride sol.                          |
|   | 23. Sulfuric acid                               |

**Staining and Mounting.**—In the staining of the powders for direct examination in temporary mounts, a small portion of the powder may be mixed with the



stain on the slide or first, in a Syracuse watch-glass and later transferred to the slide by means of a clean pipette. Deeply colored solutions of dyes, such as the Hematoxylin and Methylene Blue stains, should be used in this technique in diluted form, the exact length of time and amount of dilution required for the best staining varying with the different elements to be stained and the stain employed. It is good practice to watch the absorption of the stain by the particles in the watch-glass placed on the stage of the microscope so as to ascertain whether they are being under- or overstained, adjusting the strength of stain and time period accordingly. The mounting medium for temporary mounts may be either water, 50 per cent glycerin or a chemical reagent.

When the staining is to be followed by dehydration, clearing and permanent mounting in balsam or when used for slide smears, it is usually advisable to use the concentrated stain.

The particles in the powders are of different sizes and thicknesses and so are not stained uniformly. The smaller particles are usually the best stained in the mount. Staining the particles in the powders may be carried out either in a Syracuse watch-glass, or by the filter, smear or centrifuge methods.

The *filter method* may be carried out either with a small glass funnel, chemical filter paper and an Erlenmeyer flask or with a glass filter funnel and filter flask, both having some advantages and disadvantages.

The chief disadvantage in the use of the chemical filter paper is the appearance in some of the mounts of paper materials, especially fibers, but for most practical purposes it is satisfactory, since these can readily be distinguished from the other elements. The main disadvantages of the glass filter funnel are first, too rapid filtration for some methods of treatment of the powder and secondly, the loss of some of the material due to the particles being caught in the interstices of the filter.

The *smear method* is carried out on a microslide by the use of Mayer's Albumin Fixative. Several drops of a mixture of 1 part of Mayer's Fixative to about 30 of distilled water are placed on a clean slide and a small portion of the powder thoroughly mixed with it is rubbed over the surface with another clean slide and allowed to stand over night beneath a bell jar or improvised cover. By this process the powder becomes fixed to the slide in a thin film and can then be stained, washed, dehydrated and mounted in balsam.

The *centrifuge method* is carried out by placing the powder in a clean centrifuge tube and successively centrifuging it with stain, water, and increasing strengths of alcohol and xylol. By means of a pipette the powder is then transferred from the bottom of the centrifuge tube to a slide, spread out thereon and mounted in balsam.

#### **DISTINCTIONS BETWEEN THE POWDERED DESICCATED ANTERIOR AND POSTERIOR PITUITARY**

The determination of the desiccated lobes affords a more difficult problem than that of distinguishing between stained sections of the parts of the pituitary. This is obviously due to the alteration of many of the elements in the process of

preparing the products for the market, during which time a certain amount of shrinkage occurs in many of the cells, especially in the cytoplasm of neuroglia and glial cells including the pituicytes. Nevertheless, it is not impossible for the experienced worker to quickly distinguish between the products by means of careful technique. The author has found that a small glass funnel, flask, and chemical filter paper were useful in some of the staining technique especially where two or more stains or solutions were employed, the powder being treated on the filter paper in position within the funnel with the staining solutions and, when dry, transferred to a slide for examination. It is often found necessary to dilute some of the stains used in order to bring out cell details in some of the elements. The personal equation cannot be overlooked in this work. Usually there are a sufficient number of sufficiently thin elements present in the mounts so that the thicker, opaque masses can be passed by in making the examination, or separated by crushing or teasing apart and later examined if deemed necessary. In addition to the histological characteristics previously reported by the writer for the powdered, desiccated anterior and posterior pituitary products the following observation may be added: Powdered desiccated anterior pituitary, when treated with copper acetate solution as a mordant and subsequently stained with Weigert's hematoxylin and eosin solution and treated with Weigert's borax-ferricyanide differentiator, shows polygonal to irregularly polygonal chromophile cells containing alpha and beta granules and polygonal to irregularly polygonal chromophobe cells containing clear, non-granular, pink cytoplasm, fragments of brown-stained connective tissue and nervous tissue and occasional small circular basophiles with a blue nucleus and sky blue cytoplasm.

Powdered desiccated posterior pituitary by the aforementioned copper-hematoxylin and eosin method with Weigert's differentiator does not exhibit chromophile cells with alpha and beta granules but shows mostly brownish pituicytes and pink stained connective tissue together with a number of small rounded basophiles and a number of eosinophiles from the attached pars intermedia.

Pink-stained, wavy connective tissue fibers and brownish capillaries and glial cells and processes occur in the powders for both lobes.

The powders can next be separately treated by a modification of Penfield's method consisting of the following procedure: They are first macerated in flasks in 8 per cent. formaldehyde, the material then repeatedly washed on a filter paper placed in a funnel with distilled water containing a few drops of stronger ammonia. The folded filter paper containing the powder is then immersed in 5 per cent. solution of 40 per cent. hydrobromic acid in distilled water at 38°C. for one hour, replaced in the funnel and washed 3 times with distilled water. The powder on the filter is then macerated in 5 per cent. solution of sodium carbonate for 1 hour, the solution allowed to pass through the filter and the powder treated with Hortega's silver carbonate, weak solution (m-2) for 10 minutes. The powder is then treated with a 1 per cent. solution of formalin and washed with distilled water. It is then immersed in a 1:500 solution of

gold chloride at room temperature until of a bluish gray color after which it is fixed in a 5 per cent. solution of sodium hyposulphite, washed, dehydrated, cleared in xylol and mounted in balsam.

By this method the powdered anterior lobe shows numerous microglia and oligodendroglia but no pituicytes nor bulbous ends of nerve fibers, whereas the powdered posterior lobe shows pituicytes and non-medullated nerve fibers with bulbous ends. The non-medullated nerve fibers with bulbous ends are espe-

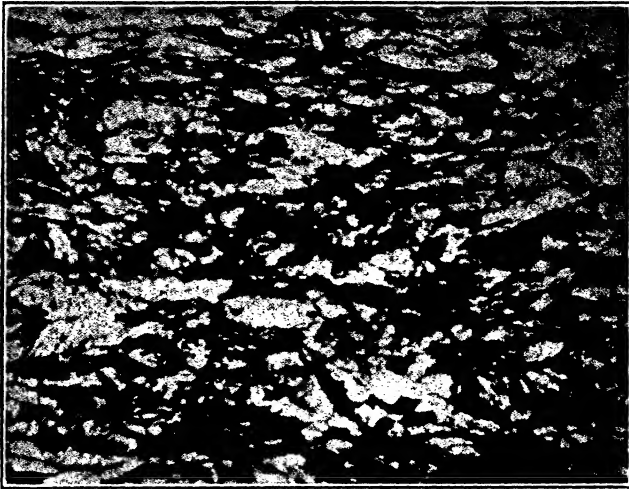


FIG. 521.—Pituicytes in a section of beef pituitary stained by the Penfield modification of the Hortega method. (After Bucy, from Penfield's, "*Cytology and Cellular Pathology of the Central Nervous System.*" Courtesy of Paul B. Hoeber, Inc., publishers.)

cially diagnostic for the posterior lobe and can also be detected with Delafield's hematoxylin and eosin and with hematoxylin and phosphotungstic acid.

**Permanent Records.**—In research work, it is always advisable to keep for future reference samples of the materials used in the investigation. These should be properly labeled. In the case of plant materials used in published investigations, properly authenticated samples should be placed in a permanent depository where they may be accessible for future reference.

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# INDEX

*Folios in boldface refer to entries of main importance.*

## A

*Abies alba*, 119  
*balsamea*, 119  
*excelsa*, 121  
*sibirica*, 131  
 Abietic anhydride, 116  
 Abrin, 478  
 Abrus, 478  
*Abrus precatorius*, 478  
 Absinth, 873  
 Absinthe grande, 873  
 Absinthium, 873  
 Acacia, 51, **451**  
     Flake, 454  
*Acacia*, 452  
     *arabica*, 917  
     *Senegal*, **452**, 453  
     *Seyal*, 454  
     *Verek*, 452  
*Acer Negundo*, 542  
     Leaves, 571  
     *saccharinum*, 543  
     *saccharum*, 132, 543  
     *spicatum*, 543  
     bark, 844, **849**, **851**  
*Aceraceæ*, 542  
 Ache celeri, 621  
 Achillea, 904  
*Achillea Millefolium*, 904, 905  
*Achras Zapota*, 646  
 Acidum Ascorbicum, 969  
     Chrysophanicum Crudum, 470  
     Nicotinicum, 970  
     Tannicum, 269  
*Acockanthera Ouabaio*, 683  
     *Schimperi*, 683  
 Aconine, 325  
 Aconite, 314  
     Indian, 325, 327  
     Japanese, 324, **325**  
     Nepal, 325  
     official, 314  
     root, 314

## Aconite—(Continued)

    stem, 323  
     Tuber, 314  
 Aconitine, 325, 328  
 Aconitknollen, 314  
 Aconitum, 23, **314**  
*Aconitum Balfourii*, 327  
     *chasmanthum*, 325  
     *deinorrhizum*, 327  
     *ferox*, 327  
     *Fischeri*, 317, **325**  
     *heterophyllum*, 328  
     *laciniatum*, 325  
     *Lycocotnum*, 328  
     *Napellus*, **314**, 315, 318  
         var. *delphinifolium*, 314  
         Sparks var., 316, 319, 321  
     *paniculatum*, 328  
     *spicatum*, 328  
     *Störckianum*, 326, **327**  
     *uncinatum* var. *japonicum*, 325  
 Acore vrai, 177  
 Acorn kernels, 834  
*Acorus Calamus*, 177  
*Actæa*, 337  
*Actinomyces Myricarum*, 258  
 Adanon, 386  
 Adeps, 934  
     Lanæ, 933  
     Hydrosus, 933  
 Adonidin, 341  
 Adonidoside, 341  
 Adonis, 41, 340  
     Spring, 340  
     Summer, 341  
*Adonis æstivalis*, 341  
     *vernalis*, 340, 341  
 Adonivernoside, 341  
 Adrenal Cortex Extract, 948  
 Adrenal Substance, Dried, 945  
 Adrenalin, 948  
 Adsorbents, 56  
 Adulteration, 4  
*Aegopodium podagraria*, fruits of, 621

- Aethusa cynapium*, 635  
 Aethylhydrocupreinæ Hydrochloridum, 822  
*Aframomum Melegueta*, 236  
 African Bdellium, 510  
 Agar, 51, 79  
     American, 80  
     Atlantic, 79, 80  
     Australian, 80  
     Japanese, 80  
 Agar-agar, 79  
 Agaric, 91  
     Fly, 93  
     Surgeon's, 91  
     White, 91  
*Agaricaceæ*, 92  
 Agaricin, 91  
 Agaricus, 91  
*Agaricus arvensis*, 92  
     *campestris*, 92  
*Agkistrodon mokasen*, 927  
     *piscivorus*, 927  
 Agouman, 303  
 Agripaume, 731  
*Agropyron repens*, 132  
     Fig. of, 133  
     Fig. of T. S. rhizome, 134  
 Ague root, 207  
     tree, 362  
*Ahmfeltia plicata*, 79  
 Ail, 182  
 Ailanthus Family, 505  
     pollen, 65  
*Ailanthus glandulosa*, 719  
 Ajowan fruit, 710  
 Alant-camphor, 900  
 Alantwurz, 897  
 Albumin, Dry, 941  
 Albuminous seeds, 47, 48  
 Alburnum, 33  
 Alcanna Root, 701  
 Alder Buckthorn, 550  
 Aleppo Galls, 266, 267  
 Aletris, 28, 207  
     farineux, 207  
*Aletris farinosa*, 207  
*Aleurites laccifera*, 917  
 Alexandria Senna, 459, 462  
 Algæ, 69  
     Blue green, 69  
     Brown, 71  
     Green, 69  
     Red, 75  
 Algin, 72  
 Alhenna, 585  
 Alkanet Root, 701  
     Syrian, 701  
 Alkanna, 21, 701  
*Alkanna tinctoria*, 701  
 Alkannawurzel, 701  
 Alkannin, 701  
 Allantoin, 702, 703  
 Allergenic Preparations, 64  
 Allergens, 61  
 Allergy, 61  
 Allerlei-Gewürz, 598  
 Allium, 29, 182  
*Allium sativum*, 29, 182  
 Allspice, 46, 598  
 Allyl Isothiocyanate, 396, 397, 398  
 Allylis Isothiocyanas, 397  
 Almond Meal, 422  
 Almond Oil, Expressed, 423  
 Almonds, Bitter, 425  
     Green, 536  
     Jordan, 421  
     Malaga, 421  
     Sweet, 421  
     Valencia, 421  
*Alnus*, 264  
 Aloe, 52, 198  
     Barbados, 202  
     Bitter, 198  
     Cape, 198, 201, 202  
     Crown, 202  
     Curaçao, 198, 201, 202  
     hepatic varieties of, 202  
     Leaf, 203  
         histology of, 199  
     Natal, 202, 203  
     Socotrine, 198, 201, 202  
     Uganda, 202  
     West Indian, 201, 202  
     Zanzibar, 202  
*Aloe africana*, 198  
     *barbadensis*, 198, 199  
     *ferox*, 198, 199  
     *Perryi*, 198, 199, 200  
     *spicata*, 198, 199  
     *vera*, 198, 199  
 Aloe-emodin, 202, 464, 549  
 Aloes, 52, 198  
 Aloin, 203  
 Alpha-estradiol, 960, 961  
 Alpha-hypophamine, 953, 956  
*Alpinia officinarum*, 227  
 Alseikraut, 873  
 Alstonia, 30

- Althæa, 21, 561  
     Leaves, 34  
*Althæa officinalis*, 561  
     *rosea*, 563  
 Althææ Folia, 34  
 Amandes amères, 425  
     douces, 421  
*Amanita muscaria*, 93  
     *phalloides*, 93  
 Amanita-toxin, 93  
 Ambergris, 942  
*Ambrosia elatior*, pollen grain, 65  
     *trifida*, 62  
 American Arbor Vitæ, 128  
     Aspidium, 99, 102  
     Cannabis, 277  
     Columbo, 674  
     Frankincense, 115  
     Ginseng, 607  
     Hellebore, 27  
     Kino, 479  
     Licorice, 434  
     Mint, 723  
     Mistletoe, 286  
     Nightshade, 303  
     Pennyroyal, 746  
     Saffron, 216  
     Sarsaparilla, 606  
     Senna, 465  
     Spikenard, 605  
     Storax, 400, 401  
     Water Hemlock, 627, 628  
     Worm root, 659  
     Wormseed, 300  
         oil, 302  
 Amerikanische Faulbaumrinde, 543  
     Nard, 605  
     Poleiminze, 746  
     Schwertel, 220  
     Wurmsamen, 300  
 Amidon Hydrochloride, 386  
 Aminophylline, 572  
 Ammoniac, 638  
 Amniotin, 964  
*Anomum aromaticum*, 234  
     *Cardomomum*, 231, 234  
     *globosum*, 234  
     *maximum*, 234  
*Ampelodesma tenax*, 91  
 Amygdala Amara, 47, 425  
     Dulcis, 47, 421  
 Amygdalin, 415  
*Amygdalus communis*, 425  
 Amylum, 52, 156  
 Amylum—(Continued)  
     Manihot, 520  
     Marantæ, 237  
*Anacardiaceæ*, 529  
 Anacardium, 536  
     Orientale, 537  
*Anacardium occidentale*, 536  
*Anacyclus Pyrethrum*, 21  
 Analgesics, 56  
*Anamirta Cocculus*, 358  
     *paniculata*, 358  
*Anaphalis margaritacea*, 906  
 Anaphrodisiacs, 56  
 Anchurin, 701  
*Andira Araroba*, 470  
 Andorn, 736  
*Andropogon muricatus*, 168  
     *nardus*, 167  
*Anemone patens*, 41, 342  
     *pratensis*, 41, 342  
     *Pulsatilla*, 41, 342  
 Anesthetics, 56  
 Anet, 634  
 Anethi Fructus, 634  
 Anethol, 306, 308, 614, 617  
 Anethum, 45  
*Anethum graveolens*, 633, 634  
*Angelica Archangelica*, 623  
     *atropurpurea*, 623  
 Angelica Fruit, 623, 624  
     Root, 634  
     Seed, 623  
 Angelicæ Fructus, 45, 623  
     Radix, 28, 634  
 Angelikasamen, 623  
 Angelikawurzel, 634  
*Angiospermæ*, 131  
 Anhalonium, 581  
 Anhydrohydroxyprogesterone, 964  
 Anhydrotics, 56  
 Animal Drugs, 53  
     official, 53, 54, 55  
 Animal Excreta, detection of, 15  
 Anis, 609  
 Anise, 45, 609, 611  
     Alicante, 610  
     Chinese Star, 306, 307  
     étoilé, 306  
     Japanese Star, 307  
     Oil, 308, 614  
     Seed, 609  
 Aniseed, 45  
 Anissame, 609  
 Anisum, 45



- Annatto, 47  
*Annelida*, 912  
 Anodynes, 56  
*Anogeissus latifolia*, 454  
 Ansérine Vermifuge, 300  
 Antacids, 56  
 Anterior Pituitary, 954  
 Anthelmintics, 56  
 Anthemis, 42  
*Anthemis Cotula*, 868, 869  
     *nobilis*, 868, 869, 870  
*Anthostyrax*, 647  
 Antiasthmatics, 56  
 Antibacterial serum, 981  
 Antibiotics, 56, 972  
 Antidiphtheric Globulins, 982  
 Antiemetics, 56  
 Antigen, defined, 981  
 Antigens, 535  
     Rhus, 64  
 Antilithics, 56  
 Antiluetics, 56  
 Antimeningococci Serum, 986  
 Antiperiodics, 57  
 Antiphlogistics, 57  
 Antipyretics, 57  
 Antiseptics, 57  
 Antisialagogues, 57  
 Anti-Snake Bite Serum, North American,  
     927  
 Antispasmodics, 57  
 Antitetanic Globulins, 984  
 Antitoxins, defined, 981, 982  
 Antitoxinum Diphthericum, 982  
     Gas-Gangrænosum Bivalens, 983  
     Pentavalens, 983  
     Trivalens, 983  
     Scarlatinæ Streptococcicum, 984  
     Tetanicum, 984  
 Antivenin, 927  
 Antizymotics, 57  
 Aperients, 58  
*Apetalæ*, 243  
 Apfelkraut, 736  
 Apfelsinenschalen, 501  
 Aphrodisiacs, 57  
*Apida*, 920  
*Apii Fructus*, 45, 621  
*Apiol*, 632, 633  
     Liquid, 633  
*Apis mellifera*, 920, 921, 922  
*apium graveolens*, 621  
*Apocynaceæ*, 677  
*Apocynum*, 27, 677  
*Apocynum androsæmifolium*, 677, 678, 679  
     *cannabinum*, 677, 678  
 Apple of Peru, 764  
     of Sodom, 775  
 Apricot Kernel Meal, 423  
     Oil, 425  
 Arabisches Gummi, 451  
*Araceæ*, 176  
*Arachis hypogæa*, 477  
 Arachis Oil, 477  
*Arachnoidiscus Ehrenbergii*, 80, 81  
 Arad, 452  
*Aralia*, 27, 605  
     *Nudicaulis*, 28  
*Aralia hispida*, 605  
     *nudicaulis*, 606  
     *racemosa*, 605  
     *spinosa*, 605  
*Araliaceæ*, 605  
 Araroba Depurata, 470  
     Purifié, 470  
 Arbe à suif, 258  
 Arbor Vitæ, 37, 128  
 Arbutin, 639, 641, 643  
 Archangel Root, 28, 634  
*Archichlamydeæ*, 243  
 Archil, 94  
*Arctium Lappa*, 896  
     *minus*, 895, 896  
*Arctostaphylos*, 639  
     *Uva Ursi*, 639  
     var. *adenotricha*, 639, 641  
     var. *coactylis*, 639, 641  
 Areca, 47, 171  
*Areca Catechu*, 171, 173  
*Arecolinæ Hydrobromidum*, 173  
*Arecoline*, 173  
 Arekanuss, 171  
 Argel Leaves, 464  
*Aristolochia reticulata*, 288  
     *Serpentaria*, 288, 333  
*Aristolochiaceæ*, 287  
*Armoracia lapathifolia*, 397  
*Armoraciæ Radix*, 397  
 Arnica, 42, 875  
     American, 875, 876  
     European, 875, 876, 877  
     Flowers, 875  
     Orange, 876  
     Root, 880  
*Arnica cordifolia*, 875, 876, 878  
     *fulgens*, 875, 876, 878  
     *montana*, 875, 876, 877, 880  
     *sororia*, 875, 876

- Arnica Radix*, 880  
*Arnica*, 879, 880  
*Arnikablüthen*, 875  
*Aroideæ*, 176  
 Arrowroot, 237  
     Bahia, 520  
     Bermuda, 237  
     Brazilian, 237, **520**  
     East Indian, 237  
     Family, 236  
     Florida, 238  
     Jamaica, 237  
     Pará, 520  
     Portland, 238  
     Queensland, 238  
     Rio, 520  
     St. Vincent, 237  
     Starch, 237  
     Tahiti, 238  
     West India, 237  
*Artemisia Absinthium*, 872, **873**  
     Cina, **885**, 886  
     *Dracunculus*, 874  
     *frigida*, 375  
     *mariima*, 886  
     *mexicana*, 886  
     *neo-mexicana*, 886  
     *pauciflora*, 886  
     *ramosa*, 886  
     *Sieberti*, 886  
     *tridentata*, pollen, **65**  
     *trifolium*, 375  
     *Wrightii*, 886  
*Arthropoda*, 913  
*Artiodactyla*, 929  
 Arum Family, 176  
     starch, 238  
*Asafoetida*, 51, **637**  
*Asagraea officinalis*, 187  
*Asaret du Canada*, 290  
*Asarum*, 28, **290**  
*Asarum canadense*, 290  
*Ascaridole*, 302  
*Asclepiadaceæ*, 685  
*Asclepiadin*, 687  
*Asclepias*, 21, **686**  
*Asclepias tuberosa*, **686**, 687  
*Ascomycetes*, **82**  
*Ascomphyllum nodosum*, 73, **74**  
 Ascorbic Acid, 969  
 Ash, 649  
     Flowering, 653  
     Leaves, 571  
     Manna, 651  
 Ash—(*Continued*)  
     Prickly, 498  
     Sea, 499  
*Asparagus*, 179  
*Aspidium*, 24, **99**  
     *adulterants*, 105  
     American, 99, 102  
     European, 99  
     Indian, 101  
     oleoresin, 105  
*Aspidium Filix-mas*, 103  
     *spinulosum*, 105, **106**  
*Aspidosperma*, 683  
*Aspidosperma Quebracho-blanco*, 683  
*Aspidospermine*, 685  
 Assay, official, 6  
 Assefétide, 637  
 Ass'-foot Leaves, 888  
 Asthma Weed, 40, **862**  
*Astragalus gummifer*, 455, **456**  
 Astringents, 57  
*Astrocaryum vulgare*, 176  
 Atabrine, 822  
*Athyrium-Filix-femina*, 106  
 Atisine, 328  
 Atropa, 750  
*Atropa acuminata*, 759  
     *Belladonna*, 750, 751, **752**, **758**  
 Atropine, **755**, 763, 764, 769  
 Aurantii Amari Cortex, 44, **502**  
     Dulcis Cortex, 45, **501**  
 Aureine, 889  
 Australian Fever Tree Leaves, 592  
     Kino, 595  
 Avena, 45, **148**  
*Avena fatua*, 149  
     *sativa*, 148, 149  
 Average dose, defined, 7  
 Aves, 928  
 Avoino, 148  
 Axonge, 934  
 Azolitmin, 95  
 Azulene, 868

## B

- Bacca Spinæ Cervinæ*, 552  
*Bacillarieæ*, 69  
*Bacillus brevis*, 978  
     *subtilis*, 980  
*Bacitracin*, 980  
 Bacterial Biological Products, 981  
     vaccine, defined, 982  
 Bacterin, defined, 982

Bacteriostatics, 57  
 Badiane, 306  
 Baies de Genièvre, 126  
     de ronce, 416  
 Balata, 647  
 Baldrianwurz, 852  
*Ballota hirsuta*, 738, 740, 741  
     *nigra*, 740  
 Balm, 731  
     Horse, 749  
     Lemon, 732  
     Stinking, 746  
 Balm of Gilead Buds, 255  
 Balsam, Canada, 119  
     Fir, 119  
     Gurjun, 435  
     Indian, 119, 436  
     Oregon, 119  
     Peru, 436  
     Poplar Buds, 255  
 Balsam of Copaiba, 434  
     of Tolu, 437  
 Balsams, defined, 51  
     official, 51  
 Balsamum Peruvianum, 51, 436  
     Tolutanum, 51, 437  
 Baneberry, 314  
 Baptisia, 21, 478  
*Baptisia tinctoria*, 478  
 Barbaloin, 202  
 Barbasco, 475  
 Barberry, 28, 343  
     Family, 344  
 Bardane, 896  
 Bärentraubenblätter, 639  
 Bark, definition, 30  
 Barks, examination of, 31, 32, 33  
     official, 30  
     powdered, 33  
     root, 31, 32  
     stem, 32  
 Bärlappsamen, 96  
 Barley, 142  
     Farina, 146  
     Figs. of, 144  
     Flour, 146  
     Pearl, 146  
     Products, 146  
 Barley Malt, 147  
*Barosma*, 490  
     *betulina*, 490, 492  
     *crenulata*, 490, 493  
     *pulchella*, 495  
     *serratifolia*, 490, 491, 492, 493

*Basidiomycetes*, 91  
 Basil, 748  
     Camphor, 375  
     Common, 748  
     Sweet, 748  
 Basilic, 748  
 Basiliennünze, 748  
 Baume de Sansonate, 436  
     de Tolu, 437  
     du Canada, 119  
     vert, 729  
 Baumwolle, 564  
 Baumwollsamensöl, 566  
 Baumwollwurzelrinde, 566  
 Bay Leaves, 34, 378  
 Bay Laurel Leaves, 378  
 Bayberry, 258  
     bark, 30, 258  
     Family, 258  
 Bdellium, 509, 510  
 Bear Wood, 543  
 Bearberry, 34, 639  
 Bear's Weed, 698  
 Bebeerine, 357, 358  
 Bebeeru Bark, 358  
 Beech Family, 265  
 Bee's Wax, 922  
     Bleached, 921  
     White, 921  
     Yellow, 922  
 Beet, Sugar, 131  
 Beggar's Buttons, 896  
 Beinwurz, 701  
 Belladonna Blätter, 758  
     Indian, 760  
     Leaf, 758  
     Root, 751, 753  
     Scopola, 763  
 Belladonnæ Folium, 40, 758  
     Radix, 21, 751  
 Belladonnawurzel, 751  
 Belladonnine, 755, 763, 769  
 Benedicten Distel, 907  
 Benjamin Tree, 647  
 Benzoe, 647  
 Benzoin, 51, 647  
     Family, 647  
     Laurel, 647  
     Siam, 647, 648, 649  
     Sumatra, 647, 648, 649  
 Benzoinum, 51, 647  
*Berberidaceæ*, 343  
 Berberine, 332, 340, 344  
 Berberis, 343

- Berberis Aquifolium*, 343, 344  
     *nervosa*, 343, 344  
     *vulgaris*, 592  
 Berberitzenwurzel, 343  
 Bermuda Grass, 135, 136, **137**  
 Berries, official, 45  
 Bertramblüthen, 880  
 Besenginster, 465  
*Beta maritima*, 131  
     *vulgaris*, **131**, 398  
 Beta-hypophamine, 953, 956  
 Betelnut, 171  
 Bethroot, 28  
*Betula alba*, 265  
     *lenta*, 264  
     *pendula*, 265  
*Betulaceae*, 264  
 Beurre de Cacao, 557  
     de Coco, 174  
 Bhang, 276  
 Bichy Nuts, 558  
 Bikhacitine, 328  
 Bile de Boeuf, 931  
     Salts, 931  
 Bilsenkrautblätter, 770  
 Birch, Black, 264  
     Family, 264  
     Sweet, 264  
     White, 265  
 Birkenöl, 265  
 Birkenrindenöl, 264  
 Birthwort Family, 287  
 Bisam, 938  
 Bissabol, 509  
 Bistorta, 25  
 Bitter Almond, 47, **425**  
     Aloes, 198  
     Apple, 45, **857**  
     Ash, 505  
     Cassava, 520  
     Herb, 41, **674**  
     Orange Oil, 503  
     Orange Peel, 44, 502  
     Root, 670  
     Stick, 41, **675**  
     Wintergreen, 641  
     Wood, 505  
 Bittere Fiebernuss, 665  
     Mandeln, 425  
 Bitterklee, 676  
 Bitterkraut, 873  
 Bittersweet, 37  
 Bitterwurzel, 670  
*Bixa orellana*, 47  
 Black Balsam, 436  
     Birch, 264  
     Cherry Leaf, 758  
     Cherry Root, 751  
     Cohosh, 27, **333**  
     Haw, 30, **837**  
     Henbane, 770  
     Indian Hemp, 27, **677**  
     Ipecac, 827  
     Mint, 725  
     Mustard, 47, **393**  
     Oak, 270  
     Pepper, 247  
     Sassafras, 373  
     Snakeroot, 333  
     Tang, 73  
     Teas, 569  
     Willow, 255  
 Blackberries, 416  
 Blackberry Bark, 30, 415  
 Black-tang, 73  
 Blackwood, 440  
 Blackwort, 701  
 Bladder Fucus, 73  
 Bladderwrack, 41, **73**  
 Blasentang, 73  
 Blasse Rose, 406  
*Blastophaga grossorum*, 280  
 Blazing Star, 209  
 Blé, 137  
 Blessed Thistle, 907  
 Blister Beetle, 918  
     Chinese, 920  
 Blood Root, 24, **387**, 388  
 Blow Ball, 891  
 Blue Bell Family, 861  
     Cohosh, 27, **344**, **345**  
     Flag, 25, **220**  
     Gum Leaves, 592  
     Rocket, 314  
     Vervain, 703  
     Weed, 700  
*Blumea balsamifera*, 378  
 Blutegel, 912  
 Blutholz, 440  
 Blutwurzel, 387  
 Bockshornsamen, 446  
*Bocconia frutescens*, 379  
 Bogbean, 676  
 Bohnenkraut, 748  
 Bois de Campêche, 440  
     de Quassie, 505  
     de Santal Blanc, 285  
     doux, 427

Bois Sang, 440  
 Boldine, 361  
 Boldo, 360  
*Boldu Boldus*, 360  
 Boldus, 34, 360  
 Bombay Coriander, 631  
 Bone Black, 969  
 Boneset, 40, 887  
 Borage, 700, 703  
   Family, 700  
*Boraginaceæ*, 700  
*Borago officinalis*, 702, 703  
 Bordeaux turpentine, 116  
 Boretsch, 703  
 Borneol, 378, 719, 722  
*Boronia serrulata*, 299  
*Bos taurus*, 932, 933, 935  
*Boswellia Carterii*, 510  
 Botanical origin, 5  
 Bouillon-blanc, 800  
 Bourrache, 703  
*Bovidæ*, 929  
 Bran, 163  
   Diabetic, 142  
   Rice, 159, 160  
   Wheat, 142  
*Brassica alba*, 390  
   *arvensis*, 396  
   *campestris* var. *chinoleifera*, 393  
   *hirta*, 390  
   *juncea*, 394  
   *Kaber*, 396  
   *Napus*, 396  
   *nigra*, 394  
 Brayera, 41, 418  
 Brazil Wood, 33  
 Brazilian Arrowroot, 237, 520  
   Cocoa, 540  
   Ipecac, 822  
   Jalap, 695  
   Krameria, 442  
   Sassafras Oil, 364  
   Wax Palm, 175  
 Brechnuss, 661  
 Breckwurzel, 822  
 British Tobacco, 888  
 Brombeeren, 416  
 Brombeerrinde, 415  
 Broom, 465  
 Broom Tops, 465  
 Brown Algæ, 71  
 Brucine, 664  
   Sulfate, 66  
*Brunfelsia*, 751

*Brunfelsia*—(Continued)  
   *Hopeana*, 21  
 Brustbeere, 553  
 Bryonia, 21, 859, 860  
*Bryonia alba*, 859  
   *dioica*, 859  
 Bryony, 21, 859  
 Bryophyta, 95  
 Bucco, 490  
 Buccoblätter, 490  
 Buchu, 34, 490  
   Long, 492, 493  
   Ovate, 493  
   Short, 492, 493, 494  
 Buckbean, 676  
 Buckthorn Bark, 30, 550  
   Berries, 552  
   Family, 543  
 Buckwheat, 161, 299  
   Family, 291  
 Bugbane, 333  
 Buku, 490  
 Bulbocapnine, 390  
 Bulbs, defined, 29  
   official and unofficial, 29  
 Bull's-foot Leaves, 888  
 Burbot Liver Oil, 927  
 Burdock, 21  
   Root, 896  
 Burgunder Harz, 121  
 Burgundisches Pech, 121  
 Burgundy Pitch, 121  
 Burnish Bush, 537  
*Burseraceæ*, 507  
*Butea frondosa*, 917  
 Butter of Cacao, 557  
 Butterfly Weed Root, 686  
 Butternut Bark, 30, 263  
 Butua, 355

## C

Cacao, 47, 554, 557  
   Butter, 557  
   Seed, 554  
   Shells, 558  
 Cachalot, 941  
*Cactaceæ*, 579  
 Cactus, 37  
   Family, 579  
   Grandiflorus, 37, 579  
*Cactus grandiflorus*, 581  
*Cæsalpinaceæ*, 427, 434  
 Café, 829

- Caffeine, 571, 833  
 Cajuput oil, 595  
 Cajuputol, 598  
 Calabar Bean, 47, **447**  
*Calamintha Nepeta*, 748  
 Calamus, 24, **177**  
*Calceolaria*, 784  
 Calciferol, 924  
 Calendula, 41, **874**  
     an adulterant, 216  
*Calendula Officinalis*, 216, 874  
 Calisaya Bark, 812, 814  
 Calmatives, 57  
*Calocarpum Sapota*, 559  
 Caltrop Family, 489  
 Calumba, 21, **352**, 353  
     Ceylon, 355  
 Cambodia, 572  
 Cambogia, 51  
 Camellia Leaves, 571  
*Camellia sinensis*, 569  
*Camelliaceæ*, 568  
*Campanulaceæ*, 861  
 Campeachy Wood, 440  
 Campecheholz, 440  
 Camphire, 585  
 Camphor, 52, **374**  
     American, 375  
     Blumea, 378  
     Borneo, 377  
     Crude, 375  
     Gum, 374  
     Laurel, 374  
     Ngai, 378  
     Synthetic, 375  
 Camphora, 52, **374**  
 Camphre, 374  
 Canada Balsam, 119  
     Moonseed, 351  
     Snakeroot, 290  
     Turpentine, 119  
 Canadian Hemp, 677  
 Canadine, 332  
 Canadische Balsam, 119  
     Gelbwurzel, 328  
     Hanfwurzel, 677  
     Haselwurzel, 290  
 Canaigre, 298  
 Candleberry, 258  
 Candlewood, 258  
 Canella, 30, **574**  
     Family, 574  
*Canella Winterana*, 574  
*Canellaceæ*, 574  
 Cannelle blanche, 574  
     de Ceylon, 368  
     de Saigon, 364  
*Canna edulis*, 238  
 Cannabinol, 280  
 Cannabis, 40, **275**  
     African, 277  
     Americana, 277  
     Indica, 275  
*Cannabis sativa*, 275  
 Cantharides, 918  
 Cantharidin, 920  
 Cantharis, 54, **918**  
*Cantharis vesicatoria*, 918  
 Caoutchouc, 517  
 Capitulum, 42  
 Caprification, 280  
*Caprifoliaceæ*, 835  
*Capriola Dactylon*, 137  
 Capsaicin, 781  
 Capsicum, 45, **776**  
     Japanese, 783  
     Louisiana, 776, 781  
*Capsicum annuum*, 783  
     var. *conoides*, 776  
     var. *longum*, 776  
     *frutescens*, 776  
 Capsique, 776  
 Capsules, (fruit) official, 45  
     de Pavot, 386  
 Caraway, 44, **617**  
     Ergotized, 621  
     Mogador, 621  
     Oil, 621  
     Seed, 617  
 Carbo Activatus, 257  
     Animalis Purificatus, 969  
     Ligni, 33, **257**  
 Cardamom, 231  
     Alleppy, 232, **234**  
     Bengal, 234  
     Ceylon-Malabar, 233  
     Ceylon-Mysore, 233,  
     Fruits, 232  
     Guatemala, 232  
     Java, 234  
     Malabar, 233  
     Mangalore, 233  
     Mysore, 233  
     Oil of, 236  
     Round, 234  
     Round Chinese, 234  
     Seed, 47, 231  
     Wild Ceylon, 234

## Cardamom—(Continued)

- Winged Java, 234
- Cardamomes, 231
- Cardamomi Semen, 47, 231
- Cardiac depressants, 57
  - stimulants, 57
  - tonics, 57
- Cardiaire, 731
- Cardol, 537
- Carica Papaya*, 578, 580
- Caricaceæ*, 578
- Carminatives, 57
- Carmine, 916
- Carminic acid, 916
- Carnauba Wax, 175
- Carnivora*, 938
- Carob Bean, 479
- Carolina Pink, 661
- Carpinus*, 264
- Carrageen, 77
- Carrageenin, 79
- Cartagena Bark, 812
  - Ipecac, 823, 825
- Carthaginian Apple, 587
- Carthamus, 909
- Carthamus helenoides*, 769
  - tinctorius*, 216, 908, 909
- Carum, 44, 617
- Carum Carvi*, 617, 619, 621
- Carvacrol, 709, 711, 713, 719
- Carvone, 621, 634
- d*-carvone, 620
- l*-carvone, 731
- Caryophyllus, 41, 600
- Caryophyllus aromaticus*, 600
- Cascara Amarga, 479
  - Sagrada, 30, 543 ✓
- Cascarilla, 527
- Cascarilla* spp., barks of, 819
- Cashew-nut, 536, 537
- Cassava, 520
  - starch, 520
- Casse, 371
  - officinale, 468
- Cassia acutifolia*, 459, 460, 462
  - angustifolia*, 459, 460, 461
  - marilandica*, 465
  - obovata*, 465
- Cassia Cinnamon, 371
  - Bark, 371
  - Buds, 372
  - Batavia, 372
  - Canton, 371
  - Chinese, 371

## Cassia—(Continued)

- Fagot, 372
- Fistula, 45, 468
- Lignea, 371
- Pods, 468
- Purging, 468
- Saigon, 364
- Stick Tree, 468
- Castanea, 34, 271
- Castanea dentata*, 271
- Castilla elastica*, 518
  - ulei*, 520
- Castor Bean, 521
  - Oil, 523
    - Plant, 521
    - Seed, 47, 522
- Cataria, 40, 713
- Catechin, 829
- Catechu, Gambir, 828
  - Pale, 828
- Cathartics, 57
- Catmint, 713
- Catnep, 713
- Catnip, 40, 713
- Cat's Hair, 526
  - Valerian, 852
  - Wort, 713
- Cattle Foods, 164
- Caulophyllum, 27, 344
- Caulophyllum thalictroides*, 344
- Caustics, 58
- Cedar, Eastern Red, 128
- Ceiba pentandra*, 50
- Celastraceæ*, 537
- Celastrus*, 537
- Celery, Fruit, 45, 621, 622
  - Salt, 622
  - Seed, 621
- Centaurium, 41, 674
- Centaurium umbellatum*, 674
- Centaury, 674
- Cephaëline, 825, 826
- Cephaëlis acuminata*, 822, 823
  - Ipecacuanha*, 821
- Cephalanthus*, 811
- Cera Alba, 921
  - Flava, 922
- Ceratonia siliqua*, 479
- Cereals, 161
  - diagnostic histological elements of, 165
- Cereus, Night Blooming, 579
- Cereus giganteus*, 579
- Cetacea*, 941

- Cetaceum, 53, **941**  
 Cetin, 942  
 Céline, 941  
 Cetraria, 94, **95**  
*Cetraria islandica*, 95  
 Cetyl palmitate, 942  
 Cevadilla, 187  
 Cevadine, 186, 187  
 Ceylon Cardamom, 232  
     Cinnamon, 30  
 Chaff, 163  
 Chamælrin, 210  
*Chamælririum luteum*, 209  
 Chamomile, English, 869, **870**  
     Fetid, 869  
     German, 42, **865**  
     Hungarian, 865  
     Roman, 42, 869, **870**  
     Wild, 865  
 Chandam, 450  
 Chanvre, 275  
     du Canada, 677  
 Charbon animal ordinaire, 969  
     de bois, 257  
 Charcoal, 257  
     Activated, 33, **257**  
     Animal, 54, **969**  
     Decolorizing, 257  
     Medicinal, 257  
     Wood, 33, **257**  
 Chardon Bénit, 907  
 Charlock, 396  
 Chaulmoogra Oil, 575  
 Checkerberry, Oil of, 643  
*Chenopodiaceæ*, 300  
 Chenopodium 45, **300**  
*Chenopodium ambrosioides* var. *anthelminticum*, **301**, 302  
 Cherry, 404  
     Black, 751, 758  
     Choke, 411, 412, **413**  
     Juice, 45, **414**  
     Leaves, 571  
     Morello, 414  
     Rum, 407  
     Sour, 414  
     Sweet, 413  
     Whiskey, 407  
     Wild, 407  
 Chestnut, 34  
     Leaves, 271  
 Chicle, 646  
 Chicory, 865  
     Root, 834, 895  
 Chiendent officinal, 132  
 Chillies, African, 776, **781**  
     Japanese, 783  
 Chimaphila, 34, 641  
*Chimaphila maculata*, 643  
     *umbellata*, **641**, 642  
     var. *cisatlantica*, 641  
 China, 812  
     Bark, 420  
     Cinnamon, 364  
     Root, 210, 227  
 Chinarinde, 812  
 Chinese Sugar cane, 132  
 Chinesischer Zimmt, 371  
 Chionanthin, 655  
 Chionanthus, 30, 32, **653**  
*Chionanthus virginicus*, **653**  
 Chirata, 41, **675**  
 Chirayita, 675  
 Chiretta, 675  
 Chirette, 675  
 Chittem Bark, 543  
 Chlorophyll, 980  
 Chocolate, 555  
     Bitter, 555  
     Liquor, 555  
     Milk, 555  
     Sweet, 555  
 Cholagogue cathartics, 57  
 Cholagogues, 58  
 Choleric, 58  
 Cholesterin, 925, 926, 938, 960, 961  
 Cholesterol, 933, 942  
 Cholic Acid, 931  
*Chondodendron polyanthium*, 358  
     *tomentosum*, **355**, 358  
 Chondrus, 41, 77  
*Chondrus crispus*, **77**, 78  
 Chorda Serica Chirurgicalis, 54  
 Chordata, 922  
 Chorionic Gonadotropin, 965  
*Choripetalæ*, 243  
 Christmas Rose, 186  
*Chrysanthemum cinerariæfolium*, **880**, 881,  
     882, 883  
     *coccineum*, **880**, 881, 883  
     *Leucanthemum*, 884  
     *Marschallii*, 880, 881, 883  
     *roseum*, **880**, 881  
 Chrysarobinum, 470  
 Chrysophanic acid, 549  
 Churrus, 275  
*Cichorium Intybus*, 895  
 Cicutia Maculata, 627, 628



- Cicutoxin, 627  
 Cimicifuga, 27, **333**, 335  
*Cimicifuga racemosa*, 333  
 Cinchona, 30, **812**  
     Alkaloids, 818  
     salts of, 820  
     Bark, 812  
     Indian, 815  
     Java, 815  
     Pale, 816  
     Red, 812, **816**, **817**  
     South American, 815  
     Yellow, 812, **816**  
*Cinchona Calisaya*, 812, 813  
     var. *lancifolia*, 817  
     *Micrantha*, 817  
     *Ledgeriana*, 812  
     *officinalis*, 816, 819  
     *pitayensis*, 814, **816**  
     *succirubra*, 812  
 Cinchonidine, 818, 821  
 Cinchonine, 818, 822  
 Cineol, 228, 236, 379, 492, 595, 723, 749  
 Cinnamon, 437  
 Cinnamic acid, 649  
 Cinnamic aldehyde, 371, 372, 373  
 Cinnamomum, 30, **364**  
     Cassia, 371  
     Saigonum, 364  
     Zeylanicum, 368  
*Cinnamomum Burmanni*, 372  
     *Camphora*, 374, **376**  
     Cassia, 372  
     *Loureirii*, **364**, 372  
     *Oliveri*, 373  
     *zeylanicum*, 369  
 Cinnamon, 364  
     Annam, 364  
     Canella, 574  
     Cassia, **371**, 373  
     Ceylon, **368**, 373 ✓  
     China, 364  
     Fagot, 372, 373  
     Java, 372  
     Oil of, 373  
     Saigon, **364**, 365, 373  
     True, 368  
     White, 574  
     Wood, 362  
 Cinquefoil, 417  
 Circulatory stimulants, 58  
 Cire blanche, 921  
     jaune, 922  
*Cissampelos Pareira*, 358  
*Cistaceæ*, 719  
*Cistus albidus*, 719  
     *salvifolius*, 719  
 Citral, 503  
 Citronella Grass, 167  
     Oil, 167  
*Citrullus Colocynthis*, 857  
*Citrus Aurantium*, 502, 503  
     *sinensis*, 501  
     *Bergamia*, 504  
     *Limon*, **503**, 504  
     *vulgaris*, 502  
 Civet, 938  
 Civetone, 939  
 Civetta, 938  
 Clavallier, 498  
 Clavatoxine, 96  
*Claviceps purpurea*, **85**  
     Figs. of 86, 89  
*Clitocybe illudens*, 93  
*Clostridium bifermentans*, 983  
     *histolyticum*, 983  
     *œdematiens*, 983  
     *perfringens*, 983  
     *septicum*, 983  
     *tetani*, 984  
 Clous aromatiques, 600  
 Clove, 41, **600**  
     Bark, 373  
     fruit, 604  
     Pepper, 598  
     stems of, **603**, **604**  
 Clover Blossoms, Red, 439  
 Cloves, 604  
     Mother of, 604  
 Club Moss, 96  
 Cnicus, 907  
*Cnicus benedictus*, 907  
 Coal Tar, 52, 120  
 Coca, 34, **485**  
     Bolivian, 488  
     Family, 485  
     Huanuco, 486  
     Java, 486, 487  
     Leaves, 485, 488  
     Peruvian, 486, 487  
     Truxillo, 486, **490**  
 Cocablätter, 485  
 Cocaine, 488, **489**  
*Coccidæ*, 914  
 Coccionella, 914  
 Cocculin, 360  
 Cocculus, 358  
     Indicus, 358

- Coccus, 53, **914**  
*Coccus cacti*, 914  
 Cochenille, 914  
 Cochineal, 53, **914**  
     Black Grain, 915  
     Granilla, 915  
     Insect, 914, 915  
     Madres, 915  
     Silver Grain, 914  
*Cochlospermum gossypium*, 560  
     *religiosum*, 458  
 Cocillana, 30, **511**  
     Bark, 511  
 Cocoa, 47, **557**  
     Bean, 554  
     Butter, 557  
     nibs, 554  
     Seed, 554  
     shells, 554  
 Coconut, 173  
     Butter, 174  
     Oil, 174  
     shells, 175  
     Shredded, 174  
*Cocos nucifera*, 173  
 Cod Fish, Fig. of, 924  
     Liver Oil, 923  
     Oil, 923  
 Codeine, **384, 385**  
*Coffea arabica*, **829**, 830  
     *liberica*, **829**  
*Coffea Tosta*, ~~47~~, **829**  
 Coffee, 829  
     adulterants of, 834  
     cross section of berry, 832  
     Hulls, 834, 835 —  
     Mocha, 831  
     Raw, 831  
     Roasted, 829  
 Coffeol, 833  
 Cohosh, Black, 333  
 Coir, 174  
 Cola, 47, **558**  
     Family, 553  
*Cola acuminata*, 558  
     *nitida*, 558  
 Colchici Cormus, 29, **188**  
     Semen, 47, **191**  
 Colchicine, 190, **191**  
*Colchicum autumnale*, 188, 191  
 Colchicum Corm, 29, **188**, 189  
     Root, 29, **188**  
     Seed, 191  
 Colchique, 188  
*Coleoptera*, 11, **917**  
 Coliander, 629  
 Colic Root, 207, 210  
 Collection of drugs, 7  
 Collinsonia, 749  
*Collinsonia canadensis*, 749  
 Colocynthis, 857  
     Apple, 857, **859**  
     Pulp, 857, **859**  
 Colocynthis, 45, **857**  
 Colombo, 352  
 Colombowurzel, 352  
 Colophone ou Arcanson, 117  
 Colophony, 117  
 Coloquinte, 857  
 Coloquinthenapfel, 857  
 Coltsfoot, 888  
     Leaves, 34, 888  
 Columba, 352  
     Ceylon, 355  
 Columbe, 352  
 Columbo, 352  
     American, 674  
 Comfrey, 700, **701**, 795  
 Commercial origin, 5  
*Commiphora*, 508  
     *abyssinica*, 508  
     *erythræa* var. *glabrescens*, 507, **509**  
     *molmol*, 508  
     *Myrrha*, 508  
     *Schimper*, 508  
*Compositæ*, 865  
     Flower heads, 42, 43  
 Comptonia, 258, **263**  
*Comptonia*, 258  
     *peregrina*, 263  
 Condor-vine Bark, 30, **687**  
 Condurango, 30, **687**  
 Cone Flower, 900  
*Coniferae*, 113  
 Conifers, 106  
 Coniine, 627  
 Conium, 45, **625**  
*Conium maculatum*, **625**  
 Consolidin, 703  
 Consoude, 701  
 Conspurgatives, 58  
 Consumptive's Weed, 698  
 Contamination, 4  
 Convallamarin, 207  
 Convallaria, 27, **203**  
     rhizome, 204, 205, 206  
     Root, 203  
*Convallaria majalis*, 203

Convallariæ Flores, 42  
 Convallarin, 207  
 Convallatoxin, 207  
*Convolvulaceæ*, 689  
 Convolvulin, 694  
 Copahu, 434  
 Copaiba, 52, **434**  
     African, 435  
     Balsam, 52, **434**  
*Copaifera*, 434  
     *guianensis*, 434  
     *Langsdorfii*, 434  
     *Jacquinii*, 434  
     *reticulata*, 434  
 Copaiva, 434  
 Copaiva balsam, 434  
*Copernicia cerifera*, 175  
 Copper-hematoxylin method, 952  
 Copra, 173  
 Coppicing, 814  
*Coprinus comatus*, 92  
 Coptide, 338  
 Coptin, 340  
 Coptis, 41, **338**  
     *groenlandica*, 338  
 Coque du Levant, 358  
 Coquelourde, 342  
 Coqueluchon, 314  
 Coriander, **629**, 630  
     Bombay, 631  
     Oil, 632  
     seed, 629  
 Coriandre, 629  
 Coriandrol, 631  
 Coriandrum, 45, **629**  
*Coriandrum sativum*, 629, 632  
*Coriaria*, 465  
     *myrtifolia*, 465, 587, 719  
 Coriariamyrtilin, 719  
 Corm, defined, 29  
     official, 29  
 Corn, 151  
     Cobs, 155  
     Dent, 153  
     Flint, 153  
     Indian, 151  
     meal, 154  
     moth, 13  
     oil, 158  
     Pod, 151  
     Pop, 153  
     products, 154, 155  
     silk, 41, **155**  
     soft, 153

Corn—(*Continued*)  
     Starch, 52, **156**  
     Sweet, 153  
     varieties of, 152, **153**  
 Cornus, 30  
*Cornus florida*, 30  
 Corpora Lutea, 963  
 Corporin, 964  
 Corpus Luteum, 963  
     Desiccated, 963  
 Correctives, 58  
 Cortex Caryophyllatus, 373  
     Quillaia, 420  
 Corticosterone, 948  
 Corydaline, 390  
 Corydalis, 389  
*Corylus*, 264  
*Corynanthe Johimbe*, 835  
*Corynebacterium diphtheria*, 986  
*Coscinum fenestratum*, 355  
 Cotarnine chloride, 386  
 Cotton, 564  
     Absorbent, 564  
     American Upland, 564  
     Oil, 566  
     Purified, 50, **564**  
     Root Bark, 30, **566**  
     Sea Island, 564  
     Thistle, 216  
     Upland, 564  
     Wild, 677  
 Cottonseed Oil, 566  
 Cotyledons, official, 47  
 Couchgrass, 27, 132  
     Fig. of, 133  
 Couleuvrée, 859  
     de Virginie, 288  
 Coumarin, 242, **446**  
 Counterirritants, 58  
 Couronne de moine, 891  
 Cousso, 418  
 Cowbane, 625, 627  
 Cow's Milk, 932  
 Crab's Eyes, 478  
 Craie Lavée, 910  
 Cramp Bark, 844  
 Cranberry Bark, 844  
     Tree Bush, 844  
 Cranesbill, 25, 479  
 Creek Gum, 595  
 Cremocarps, official, 45  
 Creosote, 271  
     carbonate, 273  
 Cresol, 121

Creta Lævigata, 910  
     Præparata, 910  
 Cretan Dittany, 711  
*Crinum*, 182  
*Crocus*, 41, 213  
     Autumn, 188  
     Meadow, 188  
     Purple, 188  
*Crocus sativus*, 213, 215  
     vernus, 216  
*Crotalinæ*, 927  
*Crotalus*, 927  
*Crotalus Antitoxin*, 927  
*Croton Eluteria*, 528  
     tiglium, 47  
 Croton seed, 47  
 Crowfoot Family, 313  
 Crown Aloes, 202  
*Cruciferae*, 390  
 Crude drugs, 3  
     adulteration of, 4  
     contamination of, 4, 15  
     collection of, 7  
     drying of, 8  
     fracture of, 6  
     occurrence of, 3, 4  
     official, 4  
     preservation of, 11, 12, 13, 14, 15  
     sampling of, 10, 11  
     substitution of, 4  
     valuation of, 8, 9, 10  
     variation in quality of, 4  
 Cubé Root, 475  
 Cubebs, 244  
     Berries, 244  
 Cubebs, 45, 244  
 Cubèbe, 244  
 Cuckoo's Cap, 314  
 Cucumber, 856  
*Cucurbita Pepo*, 856, 857  
*Cucurbitaceæ*, 856  
 Cudbear, 53, 94  
 Culver's Physic, 798  
     Root, 27, 798  
 Cumin, 611, 621  
     des Prés, 617  
 Cumini Fructus, 45  
*Cuminum Cyminum*, 621  
 Cuprea Bark, 819  
 Cupreine, 819  
*Cupuliferae*, 265  
 Curaçao Aloes, 198, 199, 201, 202  
     Orange Peel, 502  
 Curare, 358

*Curcuma*, 229  
*Curcuma angustifolia*, 237  
     leucorhiza, 237  
     longa, 229  
*Curcumin*, 221, 230  
 Curing of drugs, 8  
 Cusso, 418  
 Cuttlefish Bone, 913  
*Cycas*, 176  
 Cycloplegics, 58  
*Cydonia oblonga*, 426  
     vulgaris, 426  
*Cydonium*, 47, 426  
 Cymarin, 680  
*Cymbopogon citratus*, 167, 168  
     flexuosus, 167, 168  
     Martini var. motia, 168  
     Nardus, 167  
     Winterianus, 167  
 Cyme, 41, 42  
*Cynips tinctoria*, 266  
*Cynodon Dactylon*, 133, 137  
     Figs. of, 135, 136  
 Cynoglossine, 703  
 Cynoglossum, 703  
*Cynoglossum*, 700, 703  
     officinalis, 703  
*Cypripediæ*, 238  
*Cypripedium*, 28, 243  
*Cypripedium Calceolus* var. *pubescens*, 28  
     macranthum, 856  
 Cytisine, 478  
*Cytisus scoparius*, 465

## D

*Dæmonorops Draco*, 175  
 Dahlia, 865  
 Daisy Family, 865  
     Flowers, 884, 885  
     Method of determining percentage  
         of, in Insect Powder, 994  
 Damiana, 34  
 Dandelion, 28, 891  
     pollen grain, 65  
*Daphne Gnidium*, 583  
     Laureola, 583  
     Mezereum, 583  
*Daphnia*, 913  
 Date Palm, 168  
*Datura alba*, 769  
     fastuosa, 769  
     innoxia, 770  
     Metel, 769

*Datura*—(Continued)

- meteloides*, 770
- Stramonium*, 764, 765, 766
- Tatula*, 764, 766
- Daturine, 769
- Dead Men's Bells, 785
- Deadly Nightshade, 40
  - Leaf, 758
  - Root, 751
- Death Cup, 93
- Death's Herb, 758
- Deguelin, 475
- Dehydrocholic Acid, 931
- Dehydrocorticosterone, 948
- Delirifacients, 59
- Delphinine, 337
- Delphinium, 47
- Delphinium Ajacis*, 337
  - Staphisagria*, 337
- Demulcents, 58
- Dendrographa leucophæa*, 94
- Dent de Lion, 891
- Dentifrices, 58
- Deodorants, 58
- Depilatories, 58
- Derris, 28, 471
- Derris chinensis*, 475
  - elliptica*, 471, 472
  - malaccensis*, 471, 473
  - polyantha*, 475
  - uliginosa*, 475
- Desoxycorticosterone Acetate, 948
- Destroying Angel, 93
- Devil's Apron, 71
  - Club, 605
  - Dung, 637
  - Shoe String, 475
- Devil's-root, 581
- Dewberry, 415
- Dextrin, White, 158
- Dextrinum Album, 158
- Dextrose, 157
- Diaphoretics, 58
- Diastase, 147, 148
- Diatom frustules, official, 52
- Diatoms, 69
- Dicenta canadensis*, 389, 390
  - Cucullaria*, 389, 390
- Dick Test Toxin, 986
- Dicotyledoneæ*, 243
- Dicotyledonous rhizomes, 24, 25
  - rhizomes and roots, 27
  - roots, 21
- Dicoumarin, 478

- Dicoumarol, 478
- Dicypellium caryophyllatum*, 373
- Diethylstilbestrol, 962
- Digestants, 58
- Digitalein, 794
- Digitalin, 794
- Digitalins, 794, 795
- Digitalis, 34, 785
  - Pulverata*, 794
  - Spanish, 795
- Digitalis lanata*, 795, 797
  - purpurea*, 785, 786, 787
  - Thapsi*, 795, 796
- Digitonin, 794
- Digitoxin, 794, 795, 797
- Digitoxinum, 797
- Digoxin, 795, 797
- Digoxinum, 797
- Dill, 45, 633, 634
- Dill Seed, 634
- Dioscorea, 25, 210
- Dioscorea villosa*, 210, 211
- Dioscoreaceæ*, 210
- Diosma, 490
- Diosma succulenta*, 495
- Diphtheria Antitoxin, 982
  - Toxin, Diagnostic, 986
  - Toxoid, 985
- Dipnoi*, 923
- Diptera*, 13
- Dipterocarpaceæ*, 435
- Dipterocarpus*, 435
- Dipteryx, 444
- Dipteryx odorata*, 242, 445
  - oppositifolia*, 242, 445
- Disinfectants, 59
- Dita Bark, 30
- Dittany, Cretan, 711
- Diuretics, 59
- Dock, 21
- Dog Bane Family, 677
  - Button, 661
  - Fennel, 869
  - Grass, 132
  - Senna, 465
- Dogbane, 677
- Dogwood, 30
  - Jamaica, 30, 475
  - Poison, 533
- Doigtier, 785
- Doldenblüthiges Harnkraut, 641
- Dolophine, 386
- Dorema Ammoniacum*, 638
- Dornapfel, 764

Doses, 7

*Dracena Draco*, 179

Dragon's Blood, 175

Drastics, 58

Dreche, 147

Dried Yeast, 82

Drop Chalk, 910

Drosera, 41

*Drosera anglica*, 41

*longifolia*, 41

*rotundifolia*, 41

*Droseraceæ*, 41

Drugs, 3, 4

Animal, 53

Therapeutic Classes of, 56

Vegetable, 21, 69

Drupes, official, 45

Drying of drugs, 8

*Dryobalanops aromatica*, 377

*Dryopteris Filix-mas*, 99, 100

*marginalis*, 98, 99, 100, 104

Dulcamara, 37

Duramen, 33

Durchwachsdest, 887

Dutch Tonka, 445

Dutchman's Breeches, 389

Dwale, 751, 758

Dwarf Palmetto, 168

Pine Needle Oil, 130

## E

Eagle-vine Bark, 687

East India Kino, 467

Indian Root, 227

Arrowroot, 237

Fish Poison, 471

Myrrh, 509

Nutmeg Oil, 313

Sandalwood Oil, 286

Tamarind, 470

Tennessee Pink Root, 661

Ebers Papyrus, 16

*Eberthella typhosa*, 988, 989

Ecbolics, 59

*Echallium Elaterium*, 861

Echinacea, 27, 900, 901

*Echinacea angustifolia*, 900

*pallida*, 900

Écorce de Balaustier, 587

de boule de neige d'Amérique, 837

de Bourdaine, 550

de cerisier de Virginie, 407

de chêne, 270

Écorce—(Continued)

de condurangc, 687

de fusain, 537

de la Racine contonnier, 566

de Limon, 503

de Mézéréon, 583

de Noyer, 263

de Quillaya, 420

de Ronce noir, 415

de Sassafra, 362

d'Obier, 844

d'Orange amère, 502

d'Orange douces, 501

d'Orme, 273

éluthérienne, 527

sacrée, 543

Egg, Hen's, 928

Egyptian Privet, 585

Thorn, 451

Eibischwurz, 561

Eichenrinde, 270

Einkorn, 141

Eisenhut, 314

Eisenkraut, 703

*Elæis guineensis*, 176

*Elasmobranchii*, 922

Elastica, 517

Elaterin, 861

Elaterinum, 861

Elaterium, 861

Elatine, 861

Elder, 835

American, 836

Box, 542

Flowers, 41, 836

Poison, 533

Sweet, 836

Elecampane, 28, 897

*Elettaria Cardamomum*, 231, 234

*α-minor*, 231

*β-major*, 231, 234

Elm Bark, 273

Family, 273

Slippery, 273

*Embelia ribes*, fruits of, 247

Emetic Weed, 862

Emetics, 59

Emetine, 825, 826

Hydrochloride, 828

Emmenagogues, 59

Emmer, 141

Emodin, 202, 549, 551

Emollients, 59

*Empleurum ensatum*, 495

- Encens, 510  
 Endocrine Glands, Examination of powdered desiccated, 1003  
     gland products, 942  
 English Chamomile, 870  
*Entada phaseoloides*, 450  
     *scandens*, 450  
 Entire plant drugs, 41  
 Enzianwurzel, 670  
 Enzymes, 53, 54  
 Ephedra, 37, 107  
*Ephedra distachya*, 107, 108, 109, 110, 111  
     *equisetina*, 107, 109, 111, 112  
     *Gerardiana*, 110, 111  
     *Helvetica*, 110  
     *nebrodensis*, 111  
     *sinica*, 107, 108, 109, 110, 111, 112  
     *trifurca*, 110  
     *viridis*, 110  
 Ephedrina, 112  
 Ephedrine, 112  
 Epich, 621  
*Epilobium angustifolium*, 571  
 Epinephrine, 948  
 Epispastics, 59, 61  
 Erdnussöl, 477  
 Ergometrine, 88  
 Ergonovine, 88  
 Ergostetrine, 88  
 Ergosterol, 84  
 Ergot, 53, 85  
     de Seigle, 85  
     Domestic, 88  
         hybrid wheat, 90  
     Durum Wheat, 90  
     European, 88  
     Figs. of, 87, 89  
     of Diss, 91  
     Prepared, 89, 90  
     Russian, 88  
     Rye, 85  
     Spanish, 88  
 Ergota, 53, 85  
 Ergotamine, 88  
     Maleate, 89  
     Tartrate, 90  
 Ergotinine, 88  
 Ergotocin, 88  
 Ergotoxine, 88  
*Ericaceæ*, 639  
 Ericolin, 639, 641, 643  
 Eriodictyon, 34, 698, 699  
*Eriodictyon californicum*, 697, 698  
     *tomentosum*, 700  
*Eruca sativa*, 396  
 Erytaurin, 675  
*Erythraea Centaurium*, 674  
*Erythroxylaceæ*, 485  
*Erythroxylon Coca*, 485, 486, 489  
     *novo-granatense*, 485, 486  
     *truxillense*, 485, 486  
 Erzengelwurzel, 634  
 Escharotics, 59  
 Esere Nut, 447  
 Eserine, 449  
     Salicylate, 450  
 Essence d'Anis, 308  
     de Betula, 264  
     de Cajeput, 595  
     de Gaultheria, 643  
     de Muscade, 313  
     de Rose, 407  
 Estradiol, 960  
 Estradiolis Benzoas, 962  
 Estragol, 874  
 Estriol, 960, 961, 962  
 Estrone, 960, 961, 962  
 Estronum, 962  
 Estrogenic hormones, 961  
     Substances,  
         Water Insoluble, 964  
         Water Soluble, 965  
 Estrogens, 961  
 Ethyl chaulmoograte, 577  
 Ethylhydrocupreine Hydrochloride, 822  
*Eubatus*, 415  
 Eucalypti Gummi, 595  
 Eucalyptol, 594, 595  
 Eucalyptus, 34, 592  
     Blätter, 592  
     Gum, 595  
     Kino, 595  
     Oil, 594  
*Eucalyptus amygdalina*, 595  
     *camaldulensis*, 595  
     *falcifolia*, 595  
     *globulus*, 592, 593, 594  
     *Gunni*, 595  
     *Leucoxylon*, 595  
     *macroryncha*, 299, 595  
     *marginata*, 595  
     *piperita*, 595  
     *rostrata*, 595  
     *stellulata*, 595  
*Eucarya spicata*, 286  
*Eucheuma*, 80  
*Euchlena mexicana*, 151  
*Eugenia*, 592

- Eugenia*—(Continued)  
*caryophyllata*, 600, 604  
 Eugenol, 307, 309, 360, 379, 509, 528, 600, 604, 605  
 Euonymus, 30, 537  
*Euonymus*, 537  
*americanus*, 537  
*atropurpurens*, 537  
*Europæus*, 537  
 Eupatorin, 888  
 Eupatorium, 40, 887  
*Eupatorium perfoliatum*, 887  
*Euphorbia*, 516  
*pilulifera*, 526  
*resinifera*, 527  
 Euphorbia Pilulifera, 41, 526  
*Euphorbiaceæ*, 516  
 Euphorbium, 527  
 Euphorbiumharz, 527  
 European Aspidium, 99  
 Goat's Rue, 438  
 Mistletoe, 287  
 Raspberry, 416  
 Rhubarb, 298  
*Euspongia agaricina*, 912  
*officinalis*, 911  
*tubulifera*, 912  
*zimocca*, 911  
 Everlasting, Life, 906  
 Pearly, 907  
 Sweet, 906  
 Exalbuminous seeds, 47, 48  
 Excrescence, official, 53  
*Exogonium purga*, 690, 691  
 Expectorants, 59  
 Extract, Crude Drug, 52  
 Liver, 930  
 Ox Bile, 931  
 Extracts, allergenic, 64  
 bacterial, 64  
 crude drug, 52  
 fungus, 66  
 poison ivy, 64  
 pollen, 64  
 Extractum Fellis Bovis, 931  
 Hepatis, 930  
 Extralin, 931
- F**
- Faex Medicinalis, 82  
*Fagaceæ*, 265  
*Fagopyrum esculentum*, 161, 299  
 Fagot Cassia, 372  
*Fagus grandifolia*, 265  
 Fairbairn Test, 202  
 Fairy's Glove, 785  
 Fallkraut, 875  
 False Cola Nuts, 559  
 Hellebore, 340  
 Ipecac, 827  
 Kola Nuts, 559  
 Mace, 312  
 Pareira, 358  
 Unicorn, 209  
 Fan Palm, 168  
 Farfara, 34, 888  
 Fats, official, 53  
 Faulbaumrinde, 550  
 Amerikanische, 543  
 Fécule de Mais, 156  
 Federharz, 517  
 Feigen, 280  
 Fel Bovis, 931  
 Feldritterspornsamensamen, 337  
 Felwort, 670  
 Fenchelsamen, 614  
 Fennel, 614  
 Dog, 869  
 Fruit, 614, 616  
 Oil, 617  
 Seed, 45, 614  
 Fenouil, 614  
 puant, 634  
 Fenugreek, 47, 446  
 Ferments, 58  
 Fern Palms, 106  
 rhizome and stipes, 24  
 Ferns, 97  
*Ferula*, 609  
*Assa-fatida*, 637  
*fatida*, 637  
*galbaniflua*, 638  
*rubricaulis*, 637  
*Sumbul*, 637  
 Feuilles de Belladonne, 758  
 de Bucco, 490  
 de chataignier, 271  
 de Coca, 485  
 de digitale pourprée, 785  
 de laurier, 378  
 de Séné, 459  
 de tussilage, 888  
 d'Eriodictyon, 698  
 d'Eucalyptus, 592  
 Féve de Calabar, 447  
 de Saint Ignace, 665  
 Feverwort, 887  
 Fèves du Mexique, 554



- Fiber zibethicus*, 938  
 Fibrin Film, 941  
     Foam, 941  
 Fibrinogen, 940  
 Fichtenharz, 117  
 Ficus, 45, 280  
*Ficus Carica*, 280  
     *indica*, 917  
     *religiosa*, 917  
 Fig, 45, 280  
 Figs, 280, 281, 282, 834  
 Figue, 280  
 Figwort Family, 784  
 Filament de Mais, 155  
 Filicic acid, 105  
*Filicineæ*, 97  
 Filmarone, 105  
 Fingerhutblätter, 785  
 Fischkörner, 358  
 Fish Berry, 358  
 Flachssamen, 482  
*Flacourtiaceæ*, 575  
 Flax Family, 482  
     Mountain, 512  
 Flaxseed, 47, 482  
 Flea Seed, 802  
 Fleckstorchschnabelwurzel, 479  
*Flemingia congesta*, 529  
     *macrophylla*, 529  
 Fleur-de-Lis, 217  
 Fleur de muscade, 311  
 Fleurs d'Arnique, 875  
     de carthame, 909  
     de Chamomille commune, 865  
     de pyrèthe, 880  
     de souci, 874  
     de sureau, 836  
     de tous les mois, 874  
 Flohsamen, 802  
 Florentine Orris, 217, 218  
 Flores Cinæ, 885  
     *Tilia*, 41, 42  
     *Verbasci*, 800  
 Flour, 162  
     Corn, 155  
     Barley, 146  
     Gluten, 163  
     Graham, 141, 163  
     Wheat, 138, 142  
 Flower heads, 42, 43  
 Flowering Ash, 653  
 Flowers, definition of, 41  
     and floral parts, examination of, 42,  
         43, 44  
 Flowers, and floral parts—(*Continued*)  
     official, 41, 42  
 Fly Agaric, 93  
*Fœniculum*, 45, 614  
*Fœniculum piperitum*, 617  
     *vulgare*, 614, 615, 617  
*Foenum Graecum*, 47, 446  
 Folic Acid, 971  
 Folk's Glove, 785  
 Follicular hormone, 960  
 Follicules de Séné, 465  
 Folliculotropic hormone, 954  
 Follutein, 965  
 Food of the Gods, 637  
 Foods, cattle, 164  
     cereal, 163  
*Foraminifera*, 910  
 Fougère mâle, 99  
 Four O'clock, 694  
 Fox Tail, 96  
 Foxglove, 34, 785  
     Grecian, 795  
     Purple, 785  
 Fracture, drug, 6, 22  
 Framboises, 416  
 Frangula, 30, 550  
 Frankincense, 510  
     American, 115  
*Fraseria carolinensis*, 674  
*Fraxinus Ornus*, 651, 652  
 French Psyllium, 803, 804, 807, 810  
     Rose, 404  
 Friar's Cap, 314  
 Fringe Tree Bark, 30, 653  
 Fructus Anisi Stellati, 306  
     *Vanillæ*, 238  
 Fruit drugs, 44, 45, 46  
 Fruits, definition, 44, 45  
     examination of, 46  
     powdered, 46  
*Fucaceæ*, 73  
 Fucus, 41, 73  
*Fucus nodosus*, 73  
     *serratus*, 73, 74  
     *siliquosus*, 75  
     *vesiculosus*, 73, 75  
         Fig. of, 74  
*Fumariaceæ*, 389  
 Fumitory Family, 389  
 Fungi, 81  
     Basidia, 91  
     Gill, 92  
     Pore, 91  
     Sac, 82

*Funtumia elastica*, 520  
Fussblattwurz, 346

## G

*Gadidæ*, 923  
*Gadus morrhua*, 923, **924**, 925  
Galactagogues, 59  
Galam Gum, 451  
Galanga, 25, **227**  
Galangal, 25, **227**, 228  
Galbanum, 638  
Galbulus, official, 45  
Galega, 41, **438**  
*Galega officinalis*, 41, **438**  
Galgant, 227  
*Galium*, 811  
Galla, 53, **266**  
    d'Alep, 266  
Galläpfel, 266  
Gallerte, 969  
Galls, Aleppo, 266, 267  
    Chinese, 267, 269  
    Smyrna, 266  
    Syrian, 266  
    Turkey, 266  
    White, 268  
*Gallus domesticus*, 928  
Gama Grass, 151  
Gambier, 828  
Gambir, 52, **828**  
    cubique, 828  
Gamboge, 51, **572**, 573  
    Family, 572  
Gamma Globulins, 941  
Ganjah, 275, **276**  
Gänzefingerkraut, 417  
Garbling, defined, 7  
*Garcinia Hanburyi*, 572  
Garden Cypress, 870  
    Heliotrope, 852  
    Lavender, 722  
    Marigold, 874  
    Marjoram, 715  
    Parsley, 632  
    Rosemary, 719  
    Rue, 299  
    Sage, 741  
    Thyme, 706  
Garget Root, 303  
Garlic, 29, **182**  
Gartenlauch, 182  
Gas Gangrene Antitoxins, 983  
*Gaultheria*, 639  
    *procumbens*, **643**, 644

*Gaultheria* oil, 643  
*Gaylussacia*, 639  
Geigenharz, 117  
Geisraute, 438  
Gelatin, 969  
    Chinese, 79  
    Japanese, 79  
    Vegetable, 79  
Gélatine officinale, 969  
Gelatinum, 969  
Gelbe Neisswurz, 338  
Gelbes Wachs, 922  
Gelbwurzel, Canadische, 328  
*Gelidiaceæ*, **79**  
*Gelidium cartilagineum*, **79**, 80  
Gelose, 80  
Gelsemicine, 658  
Gelseminine, 658  
Gelsemium, 27, **655**  
*Gelsemium sempervirens*, 655, **656**, 658  
Gemeiner Sauerdorn, 343  
Genêt à balais, 465  
Gentian, 27, **670**  
    Family, 669  
Gentiana, 27, 670  
*Gentiana acaulis*, 669  
    *lutea*, 669, **670**  
    *pannonica*, 672  
    *punctata*, 672  
    *purpurea*, 672  
    *verna*, 669  
*Gentianaceæ*, 669  
Gentiopiecin, 672  
*Geraniaceæ*, 479  
Geraniol, 167, 482  
Geranium, 25, 27, **479**  
    Family, 479  
    Spotted, 479  
    Wild, 479  
*Geranium maculatum*, 479, 480  
*Gerardia*, 784  
German Chamomile, 865  
    Fennel, 614  
    Psyllium, 810  
Germerine, 187  
Germicides (*see* Disinfectants), 59  
Gerste, 142  
Gewürznelken, 600  
Ghatti Gum, 454  
Giftjasmin, 656  
Giftlattichsaft, 903  
*Gigartina mamillosa*, **77**, 78  
*Gigartinaceæ*, **76**  
Gingembre, 221

- Ginger, 24, **221**  
   African, **222**, 225  
   Bleached, 222  
   Calcutta, 223  
   Calicut, 223  
   Chinese, 227  
   Coated, 222  
   Cochin, **223**, 225  
   Family, 221  
   Jamaica, **222**, 225  
   Japanese, **223**, **226**  
   Lemon, 223  
   Limed, 222  
   Peeled, 222  
   Race, 223  
   Ratoon, 222  
   Rhizome, 221  
 Ginseng, 607  
   American, 605, **607**  
   Chinese, 607  
   Family, 605  
   Japanese, 608  
 Girofle, 600  
 Gitalin, 794  
 Gitin, 794  
 Gitoxin, 794, 795  
 Glands, 53  
 Glandula Pituitaria, 950  
 Glandulæ Rottleræ, 528  
 Glandular Products, 54, 55  
 Globulinum Immune Humanum, 941  
 Glucose, 158  
 Glucosum Liquidum, 158  
 Gluten flour, 163  
*Glyciphagus*, 13  
   *spinipes*, 12  
 Glycyrrhiza, 27, **427**  
*Glycyrrhiza glabra*, 428, 429  
   *β-violacea*, 431  
   *glandulifera*, 428  
   *typica*, 428  
   *lepidota*, 434  
   *malensis*, 428  
   *uralensis*, 434  
 Gnaphalium, 906  
*Gnaphalium obtusifolium*, 906, 907  
   *polycephalum*, 906  
*Gnetaceæ*, 106  
 Gnetum Family, 106  
 Goa powder, 471  
 Goat's Rue, 41, **438**  
   Thorn, 456  
 Goldenseal, 27, **328**  
   cultivation of, 329  
 Golden Senecio, 889  
 Goldenrod, pollen grains, 65  
 Goldthread, 41, **338**  
 Gomme Adragant, 456  
 Gommegutte, 572  
 Gooroo Nuts, 558  
 Goosefoot, 300  
   Family, 300  
 Gossypii Cortex, 566  
   Radicis Cortex, 30, 566  
*Gossypium*, 561  
   *Barbadense*, 564, 566  
   *herbaceum*, 566  
   *hirsutum*, **573**, 564, 566  
 Gossypium Purification, 50, 564  
 Goudron végétal, 120  
 Gourd Family, 856  
*Gracilaria confervoides*, 79, 80  
 Graham flour, 163  
 Grahe's Test, 818  
 Grain, 162  
 Grains, chaffy, 164  
   Guinea, 236  
   naked, 164  
 Grains of Paradise, 236  
 Graise, 934  
*Gramineæ*, **131**  
   pollen grains of, 63  
 Granatrinde, 587  
 Granatum, 30, 31, **587**  
 Grand Ciguë, 625  
 Grass Family, 131  
   Myrtle, 177  
 Greek Hay Seed, 446  
   Nuts, 421  
   Sage, 743  
 Green Hellebore, 183  
 Grenadier, 587  
 Grieswurz, 355  
 Grindelia, 40, **870**  
   Robusta, 40  
*Grindelia camporum*, 870  
   *humilis*, 870  
   *squarrosa*, 870  
 Grindelias, Table of comparison of official, 871  
 Grindelie, 870  
 Gromwell leaves, 571  
 Ground Holly, 641  
   Raspberry, 328  
 Grüner Germer, 183  
 Guaiac, 51, **489**  
   Resin, 489  
   Wood, 33

Guaiaci Lignum, 33  
 Guaiacol, 273  
     Carbonate, 273  
 Guaiacum, 51, **489**  
*Guajacum officinale*, 489  
     *sanctum*, 489  
 Guajakharz, 489  
 Guapi Bark, 511  
 Guarana, 47, **540**  
     Bread, 540  
     Paste, 540  
 Guaranine, 542  
*Guarea Bangii*, 512  
     *Rusbyi*, 511  
 Guaza, 275, **276**  
 Guinea grains, 236  
 Gum Acacia, 451  
     Arabic, 51, **451**  
     Asafetida, 637  
     Benjamin, 51, **647**  
     Bush, 698  
     Camphor, 374  
     Chicle, 646  
     Creek, 595  
     defined, 50  
     Egyptian, 451  
     Galam, 451  
     Ghatti, 454  
     Guaiac, 489  
     Hog, 456  
     Indian, 454, **458, 459**  
     Kadaya, 458  
     Karaya, 457, 458, **560**  
     Kino, 52, **467**  
     Kordofan, 452  
     Leaf, 457  
     Mesquite, 454  
     Myrrh, 507  
     Opium, 52, **379**  
     Persian, 457  
     Plant, 870  
     Red, 595  
     Resins, defined, 50  
         official, 51  
     Sapodilla, 646  
     Senegal, 451, 452  
     Sterculia, 51, 459  
     Syrian, 457  
     Talka, 454  
     Thus, **113, 115**  
     Tragacanth, 456  
     Turpentine, 113  
     West African, 452  
     Zapotl, 646

Gummi Indicum, 454  
     Plasticum, 645  
     Sterculia, 51, **560**  
 Gummic arabique vraie, 451  
 Gummigutt, 572  
 Gums, defined, 50  
     official, 51  
 Gurjun Balsam, 435  
 Gutta Gamba, 572  
     Percha, 645  
     Taban, 645  
*Guttifera*, 572  
*Gymnosperma*, 106  
 Gymnosperms, 106

## H

Habitat, 5  
 Hæmatoxylon, 440  
*Hæmatoxylon campechianum*, 440  
 Hafer, 148  
*Hagenia abyssinica*, **418, 419**  
 Hairs, cat, 14, 15  
     rodent, 14, 15  
 Halibut Liver Oil, 926  
*Haliidrys siliquosa*, 73, **75**  
*Hamamelidaceæ*, 398  
 Hamamelidis Folium, 34, **401**  
 Hamamelis Leaf, 401  
     Water, 404  
*Hamamelis virginiana*, **401, 404**  
 Hanf, 275  
*Hardwickia Mannii*, 435  
 Hareburr, 896  
 Hart's Thorn, 552  
 Hashab, 452  
 Hashish, 275  
 Hawkweed, 865  
 Heartwood, 33  
 Heath Family, 639  
 Hedeoma, 746  
*Hedeoma pulegioides*, **746, 747**  
 Heerabol, 508  
 Hefe, 82  
 Helenin, 900  
*Helichrysum arenarium*, 884  
 Heliotrope, 700  
     Garden, 852  
*Heliotropeæ*, 701  
 Hellebore, American, 27, **183**  
     European, 187  
     False, 340  
     Green, 183  
     Swamp, 183  
     White, 187

- Helleborus niger*, 186  
 Helmet Flower, 733  
 Helmkraut, 733  
 Heliotropin, 243  
 Helonias, 28; **209**  
 Hematinics, 59  
 Hematoxylon, 33, 440  
*Hemiptera*, 914  
 Hemlock, 106  
     Poison, 625  
     Spotted, 625  
     Water, 627  
 Hemostatics, 59  
 Hemp, Black Indian, 677  
     Canadian, 677  
     Fruit, 279  
     Indian, 27, **275**  
 Henbane, 40, **770**  
     Cyprus, 774  
     Egyptian, 774  
 Henna, 34, **585**, 586  
     Leaves, 585  
 Hepar cum Stomacho, 930  
 Herba Cardui Benedicti, 907  
     Centaurii Minoris, 674  
     Farfaræ, 888  
     Tanacetii, 903  
 Herbe à fièvre, 887  
     aux chats, 713  
     de lobélie enflée, 862  
     de Pyrole ombellée, 641  
 Herbs, 41  
*Heritiera littoralis*, 559  
 Herzgespam, 731  
 Hesperidin, 501, 503  
*Heteropteris pauciflora*, 828  
*Heterotheca inuloides*, 879, **880**  
*Hevea*, 517  
     *Benthamniana*, 517  
     *brasiliensis*, 517  
     *discolor*, 517  
     *pauciflora*, 517  
 Hexavitamine Capsules, 970  
     Tablets, 970  
 High Bush Blackberries, 416  
     Cranberry, 844  
 Himbeeren, 416  
*Hippoglossus hippoglossus*, 926  
*Hippospongia*, 912  
*Hirudinea*, 912  
 Hirudo, 912  
*Hirudo medicinalis*, 912  
 Histamine, 88  
     Phosphate, 90  
 Historical pharmacognosy, 15  
 Hoarhound, 736  
 Hobble-bush Bark, 850  
 Hog Gum, 456  
 Hog's Bean, 770  
 Hollyhock root, 563  
 Holunderblüten, 836  
 Holy Ghost Root, 634  
 Holzkohle, 257  
 Homatropine Hydrobromide, 756  
*Homínidæ*, 939  
 Hominy, 155  
*Homo sapiens*, 939, 940, 941  
*Homoptera*, 914  
 Honduras Bark, 479  
     Sarsaparilla, 192, 193, 195, 197  
 Honey, 54, **920**  
 Honeysuckle Family, 835  
 Honig, 920  
 Hoodwort, 733  
 Hop, 45, 282  
 Hopfen, 282  
 Hops, 282  
 Hordas, 282  
 Hordei Fructus, 142  
*Hordeum distichon*, 142  
     *hexastichon*, 142  
     *sativum*, 142  
         var. *distichon*, 142  
         var. *vulgare*, 142  
     *spontaneum*, 143  
     *vulgare*, 142  
 Horehound, 736  
     Black, 740  
     White, 736  
 Hormones, Anterior Pituitary, 954  
     Follicle stimulating, 955  
     Follicular, 960  
 Horn-seed, 85  
 Horse Balm, 749  
 Horse Nettle Berries, 775  
     Savin Berries, 126  
 Horse-foot Leaves, 888  
 Horsemint, 710  
 Horseradish root, 397  
 Houblon, 282  
 Hound's Tongue, 700, **703**  
 Huanuco Coca, 486  
 Huapi Bark, 30, **511**  
 Huflattigblätter, 888  
 Huile d'arachide, 477  
     de Cade, 130  
     de cotonnier, 566  
     de Foie de Morue, 923

## Huile—(Continued)

- de Mais, 156
- d'Olive, 650
- volatile de Goudron, 120
- de térébenthine, 116
- Human Immune Globulin, 941
- Measles Immune Serum, 987
- Scarlet Fever Immune Serum, 987
- Humulene, 256
- Humulus, 45, 282
- Humulus Lupulus*, 282
- Hydnocarpus anthelmintica*, 576
- Wighiana*, 576
- Hydnocarpus Oil, 575
- Hydragogue cathartics, 58
- Hydrangea, 28
- Hydrangea arborescens*, 28, 299
- Hydrastine, 332
- hydrochloride, 333
- Hydrastis, 27, 328, 331
- Hydrastis canadensis*, 328
- Hydrophyllaceæ*, 697
- Hydrotics, 58
- Hymenoptera*, 920
- Hyoscine, 763, 774
- Hyoscyami folium, 770
- Hyoscyamine, 755, 763, 764, 769, 774
- Hyoscyamus, 34, 40, 770
- Hyoscyamus muticus*, 774
- niger*, 770, 772
- Hypnea musciformis*, 80
- Hypnotics, 59
- Hypocreaceæ*, 85
- Hypophyse, 950
- Hypophysis, Whole Desiccated, 950
- Hypophysis Sicca, 955
- Hypoprion brevirostris*, 923
- Hyssop, Wild, 703

## I

- Iceland Lichen, 94
- Iceland Moss, 93, 95
- Ichthyomethia piscipula*, 475
- Ignace, 665
- Ignatia, 47, 665
- Amara, 665
- Ignazbohne, 665
- Illicium, 46, 306
- Illicium religiosum*, 307
- verum*, 306, 308, 614
- Indaconitine, 325
- India Rubber, 517
- Indian Aconite, 325

## Indian—(Continued)

- Balsam, 119
- Barley Caustic, 187
- Berry, 358
- Bdellium, 510
- Cannabis, 276
- Corn, 151
- Fennel, 615
- Geranium Oil, 168
- Gum, 454
- Hemp, 40, 275
- Jalap, 695
- Laburnum, 468
- Liquorice, 478
- Paint, 328
- Pink, 659
- Plantago Seed, 804
- Podophyllum, 351
- Poke, 183
- Red Paint, 387
- Root, 605
- Sage, 887
- Senna, 459
- Squill, 179, 180
- Tobacco, 862
- Tragacanth, 459
- Verbena Oil, 167
- Indigenous, defined, 5
- Indigo, Red, 94
- Wild, 21, 478
- Inflorescences, official, 41
- Ingwer, 221
- Injectio Insulini, 966
- Parathyroidei, 949
- Pituitarii Posterioris, 956
- Zinco-Insulini Protaminati, 968
- Insect Flowers, 880
- Caucasian, 881
- Dalmatian, 881
- Persian, 881
- Powder, 42, 882, 883, 884
- Insecta*, 913
- Insects in drugs, 11, 12, 13
- official, 53, 54
- Inspissated juices, 52
- Insulin, 966
- injection, 966
- Intestinal Gut, sterile, 54
- Intoxicants, 59
- Inula, 28, 897
- Inula britannica*, 880
- Conyza*, Leaves of, 795
- Helenium*, 897, 898
- Inulin, 861

Invertase, 83  
 Iodine, 71  
*Ionidium Ipecacuanha*, 828  
 Ipecac, 27, **822**  
   Black, 827  
   Brazilian, **822**  
   Cartagena, **822, 823, 825**  
   False, 827  
   Greater Striated, 827  
   Indian, 823  
   Lesser Striated, 827  
   Nicaragua, 823  
   Rio, **822, 823, 824**  
   stems, 824  
   Undulated, 827  
   White, 828  
   Yohore, 823  
*Ipecacuanha*, 27, **822**  
*Ipecacuanhæ Radix*, P. I., 822  
*Ipomœa*, 21, **696**  
*Ipomœa Batatas*, 23, 237  
   *orizabensis*, 695, **696**  
   *Turpethum*, 695  
*Iridaceæ*, 212  
 Iridin, 220  
*Iris*, 212  
   *florentina*, 216, **217**  
   *germanica*, 216, **217**  
   *pallida*, 216, **217**  
   *versicolor*, 220  
   *virginica*, 220  
*Iris*, 24, **216**  
   de Florence, 216  
   Family, 212  
   Versicolor, 25, **220**  
 Irish Broom, 465  
   Dulse, 69  
   Fig. of 76  
   Moss, **77**  
 Irsin, 220  
 Iron Bark Tree, 592  
 Irone, 220  
 Isinglass, Japanese, 79  
 Isohemaagglutinins, 941  
 Ispaghula Seed, 804  
 Ivain, 906  
 Ivory Black, 969  
   nut, 835  
 Ivy, English, 605  
   Poison, 533

## J

Jaborandi, 35, **496**  
 Maranham, 496

Jaborandi—(*Continued*)  
   Paraguay, 498  
   Pernambuco, 496  
 Jaborandiblätter, 496  
 Jack-my-lantern, 93  
 Jacob's Chariot, 314  
 Jalap, 23, 689, **690, 692**  
   Brazilian, 695  
   Indian, 695  
   Male, 695, **696**  
   Orizaba, 695, **696**  
   tubéreux, 690  
   Vera Cruz, 690  
 Jalapa, 23, **690**  
 Jalapenkollen, 690  
 Jalapenwurzel, 690  
 Jalapin, 694  
 Jamaica Dogwood, 475  
 Jamestown Weed, 764  
 Japaconitine, 325  
 Jasmine sauvage, 656  
*Jasminum fruticans*, 659  
*Jateorhiza palmata*, 353  
*Jeffersonia diphylla*, 290, 333  
 Jerusalem Oak, 300  
   Tea, 300  
 Jervine, 186, 187  
 Jesaconitine, 325  
 Jesuit's Bark, 812  
 Jimson Weed, 40, **764**  
 Johimbe, 835  
 Joint Fir, 107  
*Juglandaceæ*, 263  
 Juglans, 30, 31, **263**  
*Juglans cinerea*, 263  
 Jujube, 553  
 Juniper, 126  
   Berries, 45, **126**  
   Oil, 127  
   Tar, 130  
 Juniperus, 45, **126**  
*Juniperus communis*, **126, 127**  
   var. *depressa*, **126, 127**  
*Oxycedrus*, 130  
*Phænicea*, 128  
*Sabina*, 127  
   Fig. of T. S. of twig, 128  
*thurifera*, 128  
*virginiana*, 128  
 Jusquiame, 770

## K

Kadeöl, 130  
 Kaffee, 829

Kakaobohnen, 554  
 Kakaobutter, 557  
 Kalabarbohne, 447  
 Kalaw Tree Oil, 575  
 Kalmus, 177  
 Kamala, 50, **528**  
 Kameela, 528  
 Kamillen, 865  
 Kampher, 374  
 Kapok, 50  
 Karaya Gum, 457  
 Kardamomen, 231  
 Kaskarillrinde, 527  
 Kastanien-blätter, 271  
 Katzenminze, 713  
 Kautshuk, 517  
 Kava, 28  
 Kellerhalsrinde, 583  
 Kelps, 71  
 Kermesbeerenwurzel, 303  
*Kickxia Africana*, seeds of, 683  
 Kieselguhr, 70  
 Kino, 52, **467**  
     American, 479  
     Australian, 595  
     Cochin, 467  
     de l'Inde, 467  
     East India, 467  
     Eucalyptus, 595  
     Madras, 467  
     Malabar, 467  
 Klettenwurzel, 896  
 Knoblauch, 182  
 Knorpeltang, 77  
 Knot Root, 749  
 Kokkelskörner, 358  
 Kokosnussöl, 174  
 Kola, 558  
     Nut, 558  
         False, 559  
 Kolanuss, 558  
 Kolombowurzel, 352  
 Kondurangorinde, 687  
 Koriandersamen, 629  
 Korotrin, 965  
 Kosoblüthen, 418  
 Kousso, 418  
 Krabao oil, 576  
 Krameria, 21, **442**  
     Brazilian, 442  
     Knotty, **442**, 443  
     Para, 442, **443**  
     Peruvian, **442**, **443**  
     Savanilla, 442  
*Krameria argentea*, 442

*Krameria*—(Continued)

*Ixina*, 442  
*triandra*, 442  
*Kraunkhia floribunda*, 571  
 Kreosot, 271  
 Kreuzdornbeeren, 552  
 Krummholzlöl, 130  
 Kubeben, 244  
 Kuchenschelle, 342  
 Kümmelsamen, 617  
 Kürbissamen, 856  
 Kurkuma, 229  
 Kusso, 418

**L**

*Labiata*, 706  
 Lac, 916  
     Vaccinum, 932  
 Lacca, 916  
 Lack, 916  
 Lacmus, 94  
*Lactobacillus acidophilus*, 981  
 Lactose, 932  
 Lactosum, 53, **932**  
*Lactua*, roots of, 895  
     *virosa*, 903  
 Lactucarium, 903  
 Lactucin, 904  
 Lactucopicrin, 904  
 Ladies' Glove, 785  
     Mint, 729  
     Slipper, 28  
 Lait, 932  
 Laitue vireuse, 903  
 Lakritzenholz, 427  
*Lakshadia indica*, 916  
*Lallemantia Royleana*, **810**, **811**  
 Lamb Mint, 723  
 Lamb's Tail, 96  
*Laminaria digitata*, 72  
     *saccharina*, 72  
         Fig. of, 71  
*Laminariaceæ*, 72  
 Laminariales, 72  
 Lanatoside A, 796  
     B, 796  
     C, 796, **797**  
*Landolphia florida*, 520  
 Lanolin, 933  
     Anhydrous, 933  
 Lappa, 21, **896**  
 Laque, 916  
 Larch Agaric, 91  
     Turpentine, 118  
 Larchenschwamm, 91



- Lard, 934
  - Hog's, 934
  - Prepared, 934
- Larix decidua*, 118
  - europæa*, 118
- Lark's Claw, 337
- Larkspur, 337
- Lasioderma serricorne*, 12
- Latex, defined, 52
  - dried, purified, 53
  - official, 52
- Lauraceæ*, 361
- Laurel, Bay, 378
  - Camphor, 374
  - Family, 361
  - Grecian, 378
  - Leaves, 378, 379
- Laurus, 378
- Laurus nobilis*, 34, **378**
- Läusekörner, 337
- Lavande, 722
- Lavandin, 723
- Lavandula, 722
- Lavandula latifolia*, 723
  - officinalis*, 722
  - vera*, 722
- Lavendelblüthen, 722
- Lavender, Broadleaf, 723
  - Flowers, 722
  - Garden, 722
  - Oil, 723
- Lawsonia, 34, **585**
- Lawsonia inermis*, 585
- Laxatives, 58
- Leaf Buds, 35
  - Gum, 457
- Leaflets, official, 35
- Leaves, defined, 35
  - examination of, 35, 36
  - official, 34
  - powdered, 36
- Leaves and flowering or fruiting tops,
  - official, 40
- Lebensbaum, 129
- Leberthran, 923
- Lecanora tartarea*, 94
- Ledger Bark, 812
- Leech, 912
- Leguminosæ*, 427
- Lemon Grass Oil, 167
  - East Indian, 168
  - Peel, 45, **503**
  - Verbena, 705, **706**
- Lentisk, 535
- Leonurus, 731
- Leonurus Cardiaca*, 731
- Leopard's Bane, 875
- Lepidoptera*, 12
- Leprosy Oil, 575
- Leptandra, 27, **798**
- Leptandra virginica*, 798
- Leptandrawurzel, 798
- Leptandrin, 799
- Lesser Centaury Tops, 674
- Lessoniaceæ*, 72
- Lettuce, 865
  - Acrid, 903
  - Prickly, 903
  - roots of, 895
  - Wild, 903
- Levant Berry, 358
  - Wormseed, 885
- Levisticum, 636
- Levisticum officinale*, 636
- Levure, 82
- Liatris*, 210
- Lichenin, 95
- Lichens*, 93
- Licorice, 427
  - Alicante, 428
  - American, 434
  - extract, 428, 434
  - Italian, 430
  - Levant, 430
  - Manchurian, 434
  - Persian, **431**
  - Root, 27, **427**
  - Russian, **431**, 432
  - Seville, 428
  - Spanish, **430**
  - Toledo, 428
  - Turkish, 430
  - Wild, 434
  - Zaragosa, 428
- Liebstockelwurzel, 636
- Life Everlasting, 906
  - Root, 41, **889**, 890
- Lignum Quassia, 505
  - Santali, 285
- Ligulate floret, official, 41
- Liliaceæ*, 179
- Lilium*, 179
- Lily Family, 179
- Lily-of-the-Valley Root, 27, **203**
- Limonenschale, 503
- Limonis Cortex, 45, 503
- Linaceæ*, 482
- l-Linalyl acetate*, 723

- Linaria*, 784  
 Linden Flowers, 41, 42  
 Linseed, 482  
     Oil, 485  
 Linum, 47, 482  
*Linum usitatissimum*, 482  
 Lion's Tooth, 891  
*Lippia citriodora*, 705, 706  
 Liquid Glucose, 158  
     Storax, 398  
*Liquidambar orientalis*, 398, 399, 400  
     *styraciflua*, 398, 400  
 Liquor Hepatis, 930  
 Liquorice Root, 427  
*Liriosma ovata*, 21  
*Lithospermum officinale*, leaves, 571  
 Litmus, 94  
 Liver Extract, 930  
     Injection, 930  
     Solution, 930  
     with Stomach, 930  
 Lobelia, 40, 862  
     Family, 862  
*Lobelia inflata*, 862, 863  
*Lobeliaceæ*, 862  
 Lobelianine, 864  
 Lobelienkraut, 862  
 Lobeline, 864  
*Loganiaceæ*, 655  
 Logwood, 33, 440  
 Lonchocarpus, 475  
*Lonchocarpus nicou*, 475  
     *urucu*, 475  
     *utilis*, 475  
 Loosestrife Family, 585  
*Lophophora Williamsii*, 581  
*Loranthaceæ*, 286  
 Lorbeerblätter, 378  
*Lota maculosa*, 927  
 Lovage, 636  
 Löwenzahn, 891  
 Loxa Bark, 819  
*Lucuma mammosa*, 559  
 Lump Turpentine, 113, 116  
 Lungwort, 703  
 Lupulinum, 50, 284  
 Lupulus, 282  
 Lycaconitine, 328  
*Lycopodiaceæ*, 96  
*Lycopodineæ*, 96  
 Lycopodium, 53, 96  
     Method of Wallis, 996  
*Lycopodium clavatum*, 96  
*Lythraceæ*, 585
- M**
- Ma Huang, 107  
     Chinese, 107  
 Mace, 311  
     Bombay, 313  
     True, 311, 313  
 Macis, 311  
*Macrocystis*, 71  
     *pyrifera*, 72  
 Macrotoxin, 335  
*Macrotomia cephalotes*, 701  
 Macrotys, 333  
 Madder Family, 811  
 Maderwort, 873  
 Madweed, 733  
 Magenkraut, 873  
 Magnolia Family, 305  
*Magnoliaceæ*, 305  
     pollen grain of, 63  
 Maha Pangiri Grass, 167  
 Mahogany Family, 510  
 Mahonia, 343  
 Maiglöcklein, 203  
 Maisöl, 158  
 Maispistille, 155  
 Maisstärke, 156  
 Maize, 151  
     Figs. of, 152, 153, 154, 155  
 Majoram, 715  
     Sweet, 715  
 Majorana, 715  
*Majorana hortensis*, 715  
 Male Fern, 99  
     Jalap Root, 695  
*Mallotus philippinensis*, 528  
 Mallow Family, 560  
     Marsh, 561  
     White, 561  
 Malt, 146, 147  
     Extract, 147, 148  
 Maltum, 46  
*Malva*, 561  
     *neglecta*, 34  
     *rotundifolia*, 560  
     *sylvestris*, 34  
 Malva Leaves as adulterant, 763  
*Malvaceæ*, 560  
 Malvæ Folia, 34  
 Malz, 147  
*Mammalia*, 929  
 Manaca, 21  
 Mandeln, 422, 425  
*l*-Mandelonitrile glucoside, 412

- Mandrake, 27, **346**  
*Manettia ignita*, 827  
 Mangosteen, 572  
*Manihot*, 516  
     *dulcis* var. *Aipi*, 520  
     *esculenta*, 238, **520**  
     *Glaziovii*, 520  
     *utilissima*, 520  
*Manilkara bidentata*, 647  
 Manna, 652  
     Ash, 652  
 Manna-in-sorts, 653  
 Manne, 652  
 Mannitol, 653  
 Maple, Family, 542  
     Mountain, 543  
     Rock, 543  
     Silver, 543  
     Sugar, 132, 543  
 Maranham Jaborandi, 496  
*Maranta arundinacea*, 237  
 Maranta starch, 237  
*Marantaceæ*, 236  
 Marginal Fern, 99  
 Marigold, 874  
 Marihuana, 275  
 Marking-nut, 537  
 Marjolaine, 715  
 Marjoram, 715  
     Garden, 715  
     Leaf, 715  
     Pot, 719  
     Sweet, 715, 716  
     Wild, **719, 720**  
 Marrube blanc, 736  
 Marrubin, 740  
 Marrubium, 736  
*Marrubium peregrinum*, 740  
     *vulgare*, 735, **736**, 741  
*Marsdenia Cundurango*, 687  
 Marsh Mallow Root, 561  
     Unpeeled, 758  
 Marsh Skullcap, 736  
     Trefoil, 676  
 Marvel, 736  
     of Peru, 694  
 Maryland Pink, 659  
 Mastic, 51, **535**  
     Bombay, 536  
 Mastiche, 51, **535**  
 Mastix, 535  
 Matico, 34  
 Matricaria, 42, **865**  
*Matricaria Chamomilla*, 865, **866**  
 Maw seeds, 380  
 May Apple, 346  
 May-pop, 577  
 Mayweed, 869  
 Meadow Crocus, 188  
     Saffron Corm, 188  
     Seed, 191  
 Sage, 741  
 Meal, 163  
 Measles Prophylactic, 941  
 Meconium, 379  
 Meeriche, 73  
 Meerrettig, 397  
 Meerzwiebel, 179  
 Mehligle Aletris, 207  
 Meiran, 715  
 Mel, 54, **920**  
     Depuratum, 920  
*Melaleuca leucadendron*, 596, **597**  
*Melia*, 511  
*Meliaceæ*, 510  
 Meliatin, 677  
 Melilot, 478  
 Melilotus, 478  
*Melilotus officinalis*, 478  
 Melissa, 731  
*Melissa officinalis*, **731, 732**  
 Mélisse, 731  
 Melissenkraut, 731  
*Meloideæ*, 918  
 Menadione, 970  
*Menispermaceæ*, 351  
 Menispermum, 351  
*Menispermum canadense*, 351  
 Menispermum, 352 <  
*Mentha aquatica*, 725  
     *arvensis*, 727  
         var. *piperascens*, 728, 729  
     *canadensis*, 748  
     *Niliaca*, 725  
     *piperita*, **723**, 724, 725  
         var. *officinalis*, 725  
         var. *vulgaris*, 725  
     *Pulegium*, 748  
     *spicata*, 725, **729**  
     *viridis*, 729, 730  
 Mentha Piperita, 40, **723**  
     Viridis, 40, **729**  
 Menthe poivrée, 723  
     vert, 729  
 Menthol, 727, **729**  
 Ményanthe, 676  
 Menyanthes, 676  
*Menyanthes trifoliata*, 676

- Mepacrine Hydrochloride, 822  
 Mescal-button, 581  
 Mescaline, 582  
 Mesquite Gum, 454  
*Metazoa*, 911  
 Methadon, 386  
 Methyl Salicylate, 643, **644**  
 Methyl-testosterone, 966  
 Methylis Salicylas, 644  
 Methysticum, 28  
*Metroxylon*, 176  
     *laeve*, 176  
     *Rumphii*, 176  
     *Sagu*, 176  
*Meum athamanticum*, 617  
 Mexican Chicle, 646  
     Sarsaparilla, 192, 193, 194, **195**, **197**  
     Scammony, 696  
     Tea, 300  
     Vanilla, 239  
 Mezerein, 585  
 Mezereon, 583  
     Bark, 583  
     Family, 583  
 Mezereum, 30, **585**  
 Micrandra, 516  
 Microanalytical Methods, 993  
 Microchemical Tests, 997  
 Micrometer, 975, 1000  
 Micrometry, 999  
 Micron, defined, 999  
 Microsublimation, 9  
 Middlings, defined, 163  
     Wheat, 142  
 Miel, 920  
 Milch, 932  
 Milch-zucker, 932  
 Milfoil, 904  
 Milk, 932  
     Sugar of, 932  
 Milkweed Family, 685  
 Milkwort Family, 512  
*Mimosa*, 427  
*Mimosaceæ*, 427  
*Mimusops Balata*, 647  
 Mingwort, 873  
 Mint, 729  
     American, 723  
     Black, 725  
     Brandy, 723  
     Cat, 713  
     Common Garden, 729  
     Family, 706  
     Horse, 710  
     Mint—(Continued)  
         Japanese, 728  
         Lady's, 729  
         Lamb, 723  
         Mackerel, 729  
         Pepper, 723  
         Spear, 725, **729**  
         Squaw, 746  
         Water, 725  
         White, 725  
     Miotics, 60  
     *Mirabilis Jalapa*, 694  
     Miré, 777  
     Mistletoe, 286, 287  
         American, 286  
         European, 287  
         Family, 286  
     Mitchella, 41, 811  
     *Mitchella repens*, 41  
     Mites in drugs, 11, 12, 13  
     Mogadore Orris, 217, 218  
     Mohnkapseln, 386  
     Mohnsaft, 379  
     Mold products, 52  
     Molds in drugs, 13  
     *Mollusca*, 912  
     Mombasa Pepper, 776  
     *Monarda*, 706  
         *fistulosa*, 748  
         *punctata*, 710  
     *Monimiaceæ*, 360  
     Monkshood, 314  
     *Monocotyledoneæ*, 131  
     Monocotyledonous rhizomes, 24, 25  
         rhizomes and roots, 27, 28  
         root, 21  
     *Monotropa uniflora*, 639  
     Moonseed Family, 351  
     *Moraceæ*, 275  
     Morelle furieuse, 758  
     Morello cherry, 414  
     Morning Glory Family, 689  
     Morphine, **384**, 385, 387  
     Mortification Root, 561  
     *Morus alba*, 571  
         *nigra*, 571  
     *Moschidæ*, 936  
     Moschus, 936  
     *Moschus moschiferous*, 936  
     Moss,  
         Bog, 95  
         Club, 96  
         Iceland, 95  
         Irish, 77

Moss—(*Continued*)

- Peat, 95
- Tartarean, 94
- Moss-Rose, 406
- Mother of Cloves, 604
  - Thyme, 711
- Motherwort, 731
- Motor depressants, 60
  - excitants, 60
- Mountain Balm, 698
  - Box, 639
  - Flax, 512
  - Maple, 849
  - Tobacco, 875
- Mousse de Chine, 79
  - perlée, 77
- Moutarde blanche, 390
  - des moines, 397
  - noire, 393
- Mucilages, defined, 5
- Mucilaginous substance, official, 51
- Mucuna urens*, 450
- Muguet, 203
- Mugwort, 873
- Muir Puama, 21
- Mulberry Family, 275
  - Leaves, 571
- Mullein, Common, 800
  - Flowers, 41, **800**
  - Leaves, 34, 795, **800**
- Mulmul, 508
- Mulungu, 475
- Mundulea suberosa*, 475
- Münze, 729
- Murillo Bark, 420
- Musc, 936
- Muscade, 308
- Muscarine, 93
- Mushrooms, 92
- Musk, 936
  - American, 938
  - Artificial, 938
  - Root, 28, **637**
  - Tonquin, 936
- Muskatblüthe, 311
- Muskatöl, 313
- Muskone, 938
- Musquash, 627
- Mustard, Black, 47, **393**, 395
  - Brown, 393
  - Cake, 396
  - Chinese, 393, 394
  - Family, 390
  - Flour, 396

Mustard—(*Continued*)

- Oil, 397
- Prepared, 397
- Products, 396
- Red, 393
- seed, 396
- White, 390
- Yellow, 47, **390**
- Mutterkorn, 85
- Mutton Suet, 933
- Mycobacterium tuberculosis*, 990
- Mydriatics, 60
- Mylabris cichorii*, 920
  - sidæ, 920
- Myoctonine, 328
- Myosotis*, 700
- Myotics, 60
- Myrcia Oil, 600
- Myrica, 30, **258**
  - Myrica carolinensis*, 259
  - cerifera*, 258, **259**, **260**
  - Macfarlanei*, 260
  - pensylvanica*, 258, **260**
- Myricaceæ*, 258
- Myricyl palmitate, 922
- Myristica, 47, **308**
  - Oil, 313
- Myristica argentea*, 311
  - fragrans*, 308
  - malabarica*, 311, 313
- Myristicaceæ*, 308
- Myristicasamen, 308
- Myristicin, 310, 312
- Myroxylon Pereiræ*, 436
- Myrrh, 51, **507**
  - African, 508
  - Arabian, 508
  - East Indian, 509
  - Family, 507
  - Somali, 508
  - Yemen, 508
- Myrrha, 51, **507**
- Myrrhe, 507
- Myrtaceæ*, 592
- Myrtle Family, 592
  - Sweet, 177

## N

- Nägelein, 600
- Narcissus bulbs, 835
- Narceine, 384
- Narcotics, 60
- Narcotine, 384

- Nard Americain, 605  
*Nardostachys Jatamansii*, 637  
 Nataloin, 203  
 Naturalized, defined, 5  
*Nectandra Rodiaei*, 358  
*Neisseria intracellularis*, 987  
 Nelkenpfeffer, 598  
*Nepeta Cataria*, 713, 714  
*Nereocystis Luetkeana*, 72  
 Niacin, 970  
*Nicotiana tabacum*, 299  
 Nicotinamide, 970  
 Nicotinic Acid, 84, 970  
 Night Blooming Cereus, 579  
 Nightshade, American, 303  
     Black, 763  
     Deadly, 751, 758  
     Family, 750  
     Stinking, 770  
*Niptus hololeucus*, 12  
 Noix d'arec, 171  
     de Gourou, 558  
 Noix-vomique, 661  
*Nopalea coccinellifera*, 914  
 Normal Human Serum, 939  
 Norway Spruce, 121  
 Noyer Gris, 263  
 Nutgall, 53, 266  
 Nutmeg, 47, 308  
     Bombay, 311  
     Butter, 311  
     Family, 308  
     Macassar, 311  
     Papua, 311  
     Round, 308  
 Nux Vomica, 47, 661  
     commercial varieties of, 663, 665  
     Family, 655
- O**
- Oak, Jerusalem, 300  
     Poison, 533  
     White, 265, 266, 270  
         bark, 270  
 Oaks, 265  
 Oat, 148  
     histology, 150  
     Products, 151  
     Wild, 149, 151  
 Oats, 148  
     rolled, 151  
     Figs. of, 148, 149  
 Ochsenegalle, 931  
 Ocimum, 748  
*Ocimum Basilicum*, 748  
     *gratissimum*, 710  
     *kilimandscharicum*, 375  
*Ocotea pretiosa*, 364  
     *Rodiaei*, 358  
 Ocular Micrometer, 999  
     standardization of, 1000  
 Oeuf frais, 928  
 Official definition, 5  
 Official description, 6  
 Official drugs, 4  
 Official names, 5  
 Official rubric, 5  
 Oil, Allspice, 599  
     Almond, Bitter, 425  
     Almond, Expressed, 423  
     American Wormseed, 302  
     Anise, 308  
     Apricot Kernel, 425  
     Arachis, 477  
     Arbor Vitæ, 129  
     Australian Sandalwood, 286  
     Bay, 600  
     Benne, 800  
     Bergamot, 504  
     Betula, 264  
     Birch Tar, 265  
     Bitter Orange, 503  
     Black Birch, 264  
     Burbot Liver, 927  
     Cade, 130  
     Cajuput, 595  
     Caraway, 621  
     Cardamom, 236  
     Castor, 523  
     Cedar Leaf, 129  
     Cedarwood, 128  
     Chaulmoogra, 575  
     Checkerberry, 643  
     Chenopodium, 302  
     Cinnamon, 373  
     Citronella, 167  
     Clove, 604  
     Coconut, 174  
     Cod Liver, 923  
     Coriander, 632  
     Corn, 158  
     Cottonseed, 566  
     Dwarf Pine Needle, 130  
     Eucalyptus, 594  
     Fennel, 617  
     Galangol, 228  
     Gaultheria, 643

Oil—(*Continued*)

Gingelly, 800  
 Halibut Liver, 926  
 Hydnocarpus, 575  
 Indian Verbena, 167  
 Japanese Mint, 727, 729  
 Japanese Peppermint, 727, 729  
 Juniper, 127  
 Juniper Tar, 130  
 Lavender, 723  
 Lemon, 504  
 Lemon Grass, 167  
 Linseed, 485  
 Maize, 158  
*Mentha arvensis*, 727  
 Mountain Pine, 130  
 Mustard, 397  
 Myrcia, 600  
 Myristica, 313  
 Neroli, 503  
 Nutmeg, 313  
 Olive, 650  
 Orange, 501  
 Orange Flower, 503  
 Origanum, 719  
 Palm, 176  
 Palm Kernel, 176  
 Palmarosa, 168  
 Peach Kernel, 425  
 Peanut, 477  
 Pennyroyal, 748  
 Peppermint, 727  
 Percomorph Liver, 927  
 Persic, 425  
 Pimenta, 599  
 Pine Needle, 130  
 Pine Tar, 120  
 Rose, 407  
 Rose Geranium, 481  
 Rosemary, 722  
 Sandalwood, 286  
 Sassafras, 364  
 Sesame, 800  
 Shark Liver, 923  
 Siberian Fir, 131  
 Spearmint, 731  
 Sperm, 942  
 Spike, 723  
 Star Anise, 308  
 Sweet, 650  
 Sweet Almond, 423  
 Sweet Birch, 264  
 Sweet Orange, 501  
 Swiss Mountain Pine, 130

Oil—(*Continued*)

Tar, Rectified, 120  
 Teaberry, 643  
 Teel, 800  
 Theobroma, 557  
 Thuja, 129  
 Thyme, 710  
 Tucum, 176  
 Turpentine, 116  
 Vetiver, 168  
 Wheat Germ, 142  
 Wintergreen, 643  
 Old Man's Beard, 653  
 Old-man's Pepper, 904  
*Olea europæa*, 650  
*Oleaceæ*, 649  
 Oleo-gum-resins, 51  
 Oleoresins, defined, 51  
     official, 51, 52  
 Oleovitamin A, 970  
 Oleovitamin A and D, 970  
     Concentrated, 970  
 Oleovitamin D, Synthetic, 85, 970  
 Oleum Amygdalæ Amaræ, 425  
     Amygdalæ Expressum, 423  
 Anisi, 308  
 Arachidis, 477  
 Aurantii, 501  
 Aurantii Amari, 503  
 Aurantii Floris, 503  
 Badiani, 308  
 Bergamottæ, 504  
 Betulæ, 264  
 Betulæ Empyreumaticum Rectifica-  
     tum, 265  
 Betulinum, 265  
 Cadinum, 130  
 Cajuputi, 595  
 Cardamomi, 236  
 Cari, 621  
 Caryophylli, 604  
 Cassia, 373  
 Cedrii Folii, 129  
 Chaulmoogræ, 575  
 Chenopodii, 302  
 Cinnamomi, 373  
 Cocois, 174  
 Coriandri, 632  
 Eucalypti, 594  
 Fœniculi, 617  
 Gaultheriæ, 643  
 Gossypii Seminis, 566  
 Graminis Citrati, 167  
 Hippoglossi, 926

Oleum—(*Continued*)

- Illicii, 308
- Jecoris Aselli, 923
- Juniperi, 127
- Juniperi Empyreumaticum, 130
- Lavandulæ, 723
- Limonis, 504
- Lini, 485
- Maydis, 158
- Menthæ Piperitæ, 727
- Menthæ Viridis, 731
- Morrhua, 923
- Morrhua Non-Destearinatum, 925
- Myrciæ, 600
- Myristicæ, 313
- Olivæ, 650
- Percomorphum, 927
- Persicæ, 425
- Picis Rectificatum, 120
- Pimentæ, 599
- Pini, 117
- Pini Pumilionis, 130
- Ricini, 523
- Rosæ, 407
- Rosmarini, 722
- Rusci, 265
- Santali, 286
- Sassafras, 364
- Sesami, 800
- Terebinthinæ, 116
- Terebinthinæ Rectificatum, 116
- Theobromatis, 557
- Thymi, 710
- Olibanum, 510
- Olive Family, 649
  - oil, 650
  - pits, 604
- Olivenöl, 650
- Oliver Bark, 373
- Oncorhynchus*, 968
- Onopordon acanthium*, 216
- Onosma echioides*, 701
- Opium, 52, **379**
  - Balukissar, 382
  - Bengal abkari, 382
  - Boghaditz, 382
  - Chinese, 383
  - Druggists, 382
  - Excise, 382
  - Ghivez, 382
  - Granulated, 384
  - Indian, 383
  - Karahissar, 382
  - Malatia, 382

Opium—(*Continued*)

- Malwa, 382
- Medical, 382
- Persian, 383
- Powdered, 383
- Provision, 382
- Pulveratum, 383
- Salonica, 382
- Smyrna, 380
- Soft Shipping, 382
- Turkey, 382
- Turkish Government Monopoly, 383
- Oplopanax horridum*, 605
- Optical-crystallographic methods, 998
- Optochin Hydrochloride, 822
- Opuntia*, 579
- Orange Milk Weed Root, 686
- Orange Peel, 501
  - Curaçao, **502**, 503
  - Bitter, 44, **502**
- Oil, 501
  - Seville, 502
  - Sweet, 45, **501**
  - Wild, 502
- Root, 328
- Orcanette, 701
- Orchid Family, 238
- Orchidaceæ*, 238
- Orchideæ*, 238
- Orchil, 94
- Orchilla Weed, 94
- Ordeal Bean, 447
- Oregon Balsam, 119
- Oregon Grape Root, 343
- Organoleptic tests, 8
- Orge, 142
  - Perlé, 147
- Oriental Cashew-nut, 537
- Origanum, 719
- Origanum creticum*, 711, 719
  - Dictamnus*, 711
  - hirtum*, 719
  - Majorana*, 715
  - smyrnacum*, 719
  - vulgare*, **719**, **720**
- Orris, 24, **216**, 217
  - Fingers, 218
  - Root, 216
- Orseille de terre, 94
- Oryza sativa*, 159, **160**
- Os Sepia, 913
- Osmunda Claytoniana*, 100
  - rhizome and stipes of, **105**
- Ostindischer Enzian, 675



*Osyris alba*, 467  
 Ouabain, 683  
*Ouroparia Gambir*, 828  
 Ovarian Residue, 961  
 Ovary, 956  
     Desiccated, 956  
     Pig, 957  
 Overground portions of plants, 41  
*Ovis aries*, 933  
 Ovum, 928  
     Gallinaceum, 928  
 Ox Bile, 931  
     Extract, 53, 931  
 Oxgall, 931  
 Oxytocics (*see* Ecboics), 59  
 Oxytocin, 953, 955

## P

*Pachyrrhizus*, 475  
*Palaquium gutta*, 645  
     *oblongifolia*, 645  
 Pale Bark, 816  
     Catechu, 52, 828  
     Rose, 406  
 Palisade Ratio, 1002  
 Palm Family, 168  
     Oil, 176  
 Palma Christi, 521  
*Palmae*, 168  
 Pamaquine Naphthoate, 822  
 Panama Wood, 420  
 Panaquilon, 607  
*Panax quinquefolium*, 607  
     *repens*, 608  
*Panax Schinseng*, 607  
 Pancreas, Section of, 967  
 Pancreatin, 935  
 Pancreatine médicinale, 935  
 Pancreatinum, 935  
 Panicle, 41, 42  
 Pankreatin, 935  
 Pantopon, 386  
 Pantothenic Acid, 84  
 Papain, 53, 578  
*Papaver*, 379  
     *somniferum*, 379, 386  
     *album*, 379, 380  
     *var. nigrum*, 47, 380  
*Papaveraceae*, 379  
 Papaverine, 384  
     Hydrochloride, 385, 386  
 Papaveris Fructus, 386

Papaw Family, 578  
 Papayotin, 578  
*Papilionaceae*, 427  
 Papoid, 578  
 Pappoose Root, 344  
 Paprika, 783  
     Hungarian, 784  
     Königs, 784  
     Rosen-, 784  
     Spanish, 784  
 Papyrus Ebers, 16  
 Pará Arrowroot, 520  
 Pará Rhatany, 443, 444  
     Rubber, 517  
 Paraguay Jaborandi, 498  
 Parasitocides, 60  
 Parathyroid Gland, 949  
     Injection, 949  
 Parathyroideum, 949  
 Pareira, 21, 355, 356  
     Brava, 21, 355  
     False, 358  
*Parmeliaceae*, 95  
 Parsley Family, 608  
     Fruit, 632  
     Seed, 632  
 Parsnip root, 398  
*Parthenium argentatum*, 520  
 Partridge Berry, 41  
 Pasque Flower, 41, 342  
 Passiflora, 41, 577  
*Passiflora incarnata*, 577  
*Passifloraceae*, 577  
 Passion Flower, 41, 577  
     Family, 577  
     Vine, 577  
 Paste, consisting chiefly of crushed seeds,  
     47  
 Pasteur Prophylactic, 988  
     Treatment, 988  
*Pasteurella pestis*, 989  
*Pastinaca sativa*, 398  
*Paullinia Cupana*, 540, 541  
*Paulownia tomentosa*, 774  
 Pavot officinal, 379  
 Pawpaw, 579  
*Payena*, 645  
     *Leerii*, 645  
 Pea and Bean Family, 427  
 Peach Kernel Meal, 423, 424  
     Oil, 425  
 Peanut Oil, 477  
 Peat Moss, 95  
 Pectin, 52, 504

- Pectinum, 52, **504**  
*Pedaliaceæ*, 800  
*Pelargonium*, 479  
     *crispum*, 481  
     *graveolens*, 481  
     *odoratissimum*, 481  
     *radula*, 481  
     *roseum*, 481  
 Pelletierinæ Tannas, 592  
 Pelletierine, 591  
 Pellitory Root, 21  
 Pellotine, 582  
 Pelosine, 357  
 Penfield's Method, modification of, 1005  
 Penicillin, 972  
     Calcium, 52, **975**  
     Sodium, 52, **975**  
*Penicillium chrysogenum*, 972, 973, 975  
     *notatum*, **972**, 973, 974, 975  
 Pennyroyal, 746  
     American, 746  
     European, 748  
 Pepo, 47, **856**  
 Pepper, 46, **247**  
     Acheen, 252  
     Adulterants of, 252  
     Black, 247  
     Cayenne, 776  
     Clove, 598  
     Corn, 247  
     Family, 244  
     Garden, 783  
     Jamaica, 598  
     Long, 253  
     Louisiana Long, 776, 781  
     Louisiana Sport, 776, 781  
     Mombasa, 776, 778  
     Nyasaland, 776  
     Old Man's, 904  
     Red, 776  
     Sierra Leone, 776  
     Tailed, 244  
     Tobasco, 781  
     White, 252  
     Wild, 583  
     Wood, 499  
     Zanzibar, 776  
 Peppermint, 40, **723**  
 Pepsin, 935  
     Saccharated, 935  
 Pepsinum, 935  
 Perlgerste, 147  
 Pernambuco Jaborandi, 496  
 Perpolitones Oryzæ, 45, 52, **159**  
 Persic Oil, 425  
 Persil, 632  
 Persio, 53, **94**  
 Peruvian Balsam, 51, **436**  
     Bark, Red, 812  
     Yellow, 812  
     Krameria, 442, 443  
     Rhatany, 442  
 Peruvianische Rinde, 812  
 Pestilenzkraut, 438  
 Petersilie, 632  
 Petite centaurée, 674  
 Petrographic microscope, 998  
 Petroselini Radix, 21  
 Petroselinum, 632  
*Petroselinum crispum*, 632  
     *sativum*, 632  
*Peucedanum graveolens*, 634  
*Peumus Boldus*, 360  
 Peyote, 581, **582**  
 Pfaffenröhrchen, 891  
 Pfefferminze, 723  
 Pflaume, 426  
*Phæophyceæ*, 71  
 Phanerogamia, 106  
 Pharmacognosy, defined, 3  
     historical, 15  
*Phasianidæ*, 928  
 Pheasant's Eye, 340  
 Phellandrene, 116, 624  
 Pheophytins, 980  
*Philodendron*, 198  
*Phlomis*, 746  
*Phlox Carolina*, 661  
     *ovata*, 661  
 Phoenix dactylifera, 168  
 Phoradendron, 286  
*Phoradendron flavescens*, 286  
 Phycoerythrin, 76  
 Phycophæin, 71  
 Phycoxanthin, 71  
*Physeter macrocephalus*, 941, 942  
*Physeteridæ*, 941  
 Physostigma, 47, **447**  
*Physostigma cylindrospermum*, 450  
     *venenosum*, **447**, 448  
 Physostigmine, 449  
     Salicylate, 450  
*Phytalephas macrocarpa*, 835  
 Phytolacca, 21, **303**  
*Phytolacca americana*, **303**, 756  
     *decandra*, 303  
*Phytolaccaceæ*, 303  
 Phytomelane, 903

- Picea*, 113  
     *Abies*, 121  
     *excelsa*, 121  
*Picrasma excelsa*, 505  
*Picropodophyllin*, 350  
*Picrotoxin*, 359, 360  
 Pig Family, 934  
 Pigeon Berry, 303  
 Pill Bearing Spurge, 526  
*Pilocarpine*, 498  
*Pilocarpus*, 35, 496  
*Pilocarpus Jaborandi*, 496  
     *microphyllus*, 496  
     *pennatifolius*, 498  
*Pimenta*, 46, 598  
*Pimenta acris*, 600  
     *officinalis*, 598  
     *racemosa*, 600  
*Pimento*, 598  
*Pimenton*, 784  
*Pimiento*, 784  
*Pimpinella anisum*, 308, 609, 610, 614  
*Pinaceæ*, 113  
 Pine Bark, 122  
     Family, 113  
     Oil, 117  
     Pollen, 97  
     Tar, 120  
         Oil, 120  
     Weymouth, 122  
     White, 122  
*Pinene*, 116, 119, 127, 129, 130, 375  
*Pink Root*, 28, 659  
     East Tennessee, 661  
*Pinus Alba*, 30, 31, 122  
*Pinus caribæa*, 113  
     *cubensis*, 113  
     *echinata*, 113  
     *maritima*, 116  
     *Mugo*, 130  
     *palustris*, 113, 116, 117, 120  
         Figs. of trunk, showing turpentin-  
         ing, 114  
     *Pumilio*, 130  
     *rigida*, 120  
     *Strobilus*, 122  
     *Tæda*, 113  
 Pipe Gamboge, 572  
*Piper*, 46, 247  
*Piper angustifolium*, 34  
     *belle*, 171  
     *cubeba*, 244  
         var. *rinæ badak*, 247  
     *longum*, 253  
*Piper*—(Continued)  
     *methysticum*, 28  
     *nigrum*, 247, 248  
     *officinatum*, 253  
     *retrofractum*, 253  
     *ribesoides*, 247  
*Piperaceæ*, 244  
*Piperine*, 251  
*Pipsissewa*, 34, 641  
*Piptostegia Pisonis*, root of, 695  
*Piptostegia Root*, 695  
*Pisces*, 923  
*Piscidia*, 30, 475  
*Piscidia Erythrina*, 475  
     *piscipula*, 475, 476  
*Pistachio Nuts*, 536  
*Pistacia Galls*, 535  
*Pistacia Khinjuk*, 536  
     *Lentiscus*, 535  
     *mutica*, 536  
     *Terebinthinus*, 536  
     *vera*, 536  
*Pitch*, 120  
     Burgundy, 121  
*Pith*, 33  
*Pitocin*, 953, 955  
     Ampuls of, 956  
*Pitressin*, 953, 955  
     Ampuls of, 956  
*Pituicytes*, 1006  
*Pituitarium Anterior*, 954  
     Posterior, 955  
     Totum, 950  
*Pituitary Body*, 950  
     Desiccated Anterior, 954  
     Glands, 950  
         Distinctions between powdered  
         desiccated, 1004  
     Posterior, 955  
     Substance, 950  
     Whole, 950  
*Pix Burgundica*, 121  
     Carbonis, 52, 120  
     Juniperi, 52, 130  
     Liquida, 120  
     Lithanthracis, 120  
     Pini, 52, 120  
*Placental Extract*, 941  
*Plant Hairs*, official, 50  
*Plantaginaceæ*, 802  
*Plantaginis Semen*, 47, 802  
*Plantago arenaria*, 802, 803  
     *Cynops*, 809, 810  
     *indica*, 802, 803

*Plantago*—(Continued)

- lanceolata*, 810
- major*, 802
- ovata*, 802, 803, 805, 807
- Psyllium*, 802, 803, 805
- ramosa*, 802
- Plantago* Seed, 802
- Plantain, Common, 802
  - English, 810
  - Family, 802
  - Seed, 802
- Plants, hayfever, 61, 62
- Plasma, Dried, 940
  - Fractions, 940
  - Frozen, 940
  - Humanum Normale Citratum, 940
  - Liquid, 940
- Plasmochin, 822
- Pleurisy Root, 21, 686
- Pleuronectidæ*, 926
- Plum, 426
  - Damson, 426
- Pneumonia Serum, 987
- Poaya, 822
- Pocan, 303
- Podophyllin, 351
- Podophyllotoxin, 350
- Podophyllum, 27, 346, 347 ✓
  - American, 351
  - Indian, 351
- Podophyllum Emodi*, 351
  - peltatum*, 346, 347, 348
- Poison dogwood, 533
  - elder, 533
  - Hemlock, 625
  - Ivy, 532, 533
    - antigen, 64
    - extract, 535
  - Nut, 661
  - Oak, 533
    - sumac, 533
- Poivre noir, 247
- Poix blanche, 121
  - de Bourgogne, 121
- Poke, 303
  - Family, 303
  - Indian, 183
  - Leaves, 763
- Pokeroot, 21, 303, 756
- Poleiminze, 752
- Pollen, 44
  - counts, 64
  - extracts, 64

## Pollen—(Continued)

- grains, preparation for microscopical examination, 44
  - Figs. of, 63, 65
- Polygala* de Virginie, 512
- Polygala lutea*, 513
  - Senega*, 512, 513
- Polygalaceæ*, 512
- Polygonaceæ*, 291
- Polygonatum*, 179
- Polygonum Bistorta*, 25
- Polypodiaceæ*, 99
- Polypodium Family, 99
- Polyporaceæ*, 91
- Polypore du Méleze, 91
- Polyporus fomentarius*, 91
  - officinalis*, 91
- Pomegranate, 587
  - Bark, 587, 590
  - Family, 587
- Pomeranzenschale, 502
- Pomme-épineuse, 764
- Pompion, 856
- Poplar, 254
  - Balsam, 255
  - bark, 255
  - bud, 35, 255
  - Silver, 255
- Poppy, 379
  - Capsules, 386
  - Family, 379
  - Fruits, 386
  - Oil, 387
  - Opium, 379
  - Seed, 47
- Populi Gemma*, 35, 255
- Populus, 254
- Populus alba*, 254, 255
  - balsamifera*, 255
  - candicans*, 255, 256
  - Tacamahacca*, 255, 256
- Pore Fungi, 91
- Porifera*, 911
- Potato, 23
  - starch, 24
  - tuber, 23, 24
- Potentilla Anserina*, 417
- Potentilla Anserina*, 417
  - argentea*, 418
  - pacifica*, 418
- Pouliot américain, 746
- Präparirte Kreide, 910
- Prayer Beads, 478
- Premarin, 965

Prepared Chalk, 910  
 Suet, 55, 933  
 Preservation of drugs, 11  
 Preserved Pulp, 46  
 Prickly Ash, Bark, 498  
 Berry, 45, 500  
 Lettuce, 903  
*Primates*, 939  
 Prince's Pine, 641  
 Privet, 650  
 Procaine Penicillin, 976  
 Progesterin, 960, 964  
 Progesterone, 960, 964  
 Prolactin, 954  
 Prolan A, 953, 954  
 B, 953, 954  
*Prosopis chilensis*, 454  
 Protamine Zinc Insulin Injection, 968  
 Protectives, 60  
 Prothrombin, 941  
 Protoveratrine, 387  
*Protozoa*, 910  
 Provender, 151  
 Prune, 426  
 Pruneau noir, 426  
 Prunum, 46, 426  
*Prunus Amygdalus*, 423  
 var. *amara*, 425  
 var. *dulcis*, 421  
*Armeniaca*, 425  
*avium*, 413  
*Cerasus*, 414  
*domestica*, 426  
*Persica*, 425  
*serotina*, 407, 408, 409, 410  
*virginiana*, 407, 411, 413  
*Prunus Virginiana*, 30, 407  
*Psalliotia campestris*, 92  
 Pseudoaconitine, 327  
*Pseudomonas radiculicola*, 427  
*Pseudotsuga Douglasii*, 119  
*taxifolia*, 119  
*Psoralea obliqua*, 495  
*Psychotria emetica*, 827  
 Psychotrine, 825  
 Psyllium Seed, 47, 802  
 Black, 804  
 Blonde, 803  
 Brown, 804  
 German, 810  
 French, 803  
 Spanish, 803, 804  
 White, 804  
*Ptelea foliata*, 539

*Pteridophyta*, 96  
*Pterocarpus Marsupium*, 467  
*santalinus*, 450  
*Plinida*, 12  
*Ptinus brunneus*, 12  
*Puccinia malvacearum*, 14  
 Pulegone, 711, 748  
 Pulmonaria, 703  
*Pulmonaria officinalis*, 703  
 Pulsatilla, 41, 342  
 Pumpkin Seed, 47, 856  
*Punica Granatum*, 587, 588, 591, 592  
*Punicaceæ*, 587  
 Purgatives, 58  
 Purgiercassie, 468  
 Purging Cassia, 468, 469  
 Purified Animal Charcoal, 969  
 Cotton, 50, 564  
 Infusorial Earth, 70  
 Kieselguhr, 70  
 Siliceous Earth, 52, 70  
 Purity Rubric, 5  
 Purple Cone Flower, 27, 900  
 Purpurea-glycoside-A, 794, 796  
 Purpurea-glycoside-B, 794, 796  
 Pustulants, 60  
 Pyrethri Flores, 880  
 Pyrethrin I, 884  
 II, 884  
 Pyrethrum, 42, 880  
 Flowers, 880  
 Pyridoxine, 84

## Q

Quack Grass, 132  
 Quaker Bonnet, 733  
 Button, 661  
 Quantitative Microanalysis, 993  
 Quassia, 33, 505  
 Jamaica, 507  
 Surinam, 507  
*Quassia amara*, 505  
 Quassienholz, 505  
 Quebracho, 683  
 Bark, 683  
 Colorado, 536, 684  
 Red, 536  
 White, 683  
 Wood, 536  
 Queckenwurzels, 132  
 Queen's Delight, 523  
 Root, 523  
 Quendel, 711  
 Quercus, 30, 31, 32, 33, 270

*Quercus alba*, 265, **270**  
*chrysolepis*, 265  
*garryana*, 265  
*infectoria*, 266, 269  
*lusitanica*, 266  
*Michauxii*, 265  
*montana*, 265  
*occidentalis*, 266  
*platanoides*, 265  
*Suber*, 266  
*velutina*, 265  
*virginiana*, 265  
 Quillaja, 30, 31  
*Quillaja Saponaria*, 420  
 Quinacrine Hydrochloride, 822  
 Quince Seed, 47, **426**  
 Quinidine, 818, 819  
   Sulfate, 821  
 Quinina, 820  
 Quinine, 818, 819, **820**  
   official salts of, 820, 821  
 Quinquina, 812  
 Quittensamen, 426

## R

Rabies Vaccine, 988  
 Raceme, 42  
 Racine brésilienne, 822  
   d'Acetée à Grappes, 333  
   d'angélique, 634  
   d'asclépiade tubéreuse, 686  
   d'aune, 897  
   de Bec-de-Grue tacheté, 479  
   de Belladonne, 751  
   de Columbe, 352  
   de Galanga, 227  
   de Gentiane jaune, 670  
   de Guimauve, 561  
   de Phytolaque, 303  
   de Salsepareille, 193  
   de Valériane, 852  
   de Véronique, 798  
   d'ours, 639  
   du St. Esprit, 634  
 Radix Acori, 177  
   Bardanæ, 896  
   Calami Aromatici, 177  
   dulcis, 427  
   Ginseng, 607  
   Jalapæ, 690  
   Scopolia, 763  
 Ragweed, Giant, 62  
 Ragwort, 889  
 Raifort, 397  
*Ramona stachyoides*, 375  
*Ranunculaceæ*, 313  
 Rape Seed, 396  
 Rasin d'ours, 639  
 Raspberry, 416  
   Ground, 328  
   Juice, 45, **417**  
 Ratanhia, 442  
 Ratanhiawurzel, 442  
 Rattlesnake Root, 512  
 Rectified Tar Oil, 120  
   Turpentine Oil, 116  
 Red Algæ, **75**  
   Bark, 812  
   Bearberry, 639  
   Cinchona, 811, **812**, **814**, 815, **816**,  
     **817**, 818, 819  
   Clover Blossoms, 42, **439**  
   Gum, 595  
   Indigo, 94  
   Ink Plant, 303  
   Mustard, 393  
   Pepper, 776  
   Peruvian Bark, 812  
   Puccoon, 387  
   Quebracho wood, 536  
   Raspberries, 416  
   Root, 387  
   Rose, 404  
   Sandalwood, 450  
   Santal, 450  
   Sarsaparilla, 193  
   Saunders, 33, **450**  
   Scale Insect, 914  
   Squill, 180, **182**  
   Top, pollen grain, 63  
 Refrigerants, 60  
 Réglisse, 427  
*Remijia pedunculata*, 819, 820, 821  
   cross section of bark, 819  
   *Purdieana*, 819  
 Rennin, 933  
 Renninum, 933  
*Reptilia*, 927  
 Residuum Ovarii, 961  
 Resina, 51, 117  
   Drastica, 695  
   Lacca, 916  
   Mastiche, 535  
 Résine d'Euphorbe, 527  
   de Gayac, 489  
 Resins, defined, 50  
   official, 51

- Respiratory sedatives, 60  
stimulants, 60
- Rhabarbarum, 293
- Rhabarberwurzel, 293
- Rhamnaceæ*, 543
- Rhamnus californica*, 549  
  *carniolica*, 552  
  *cathartica*, 552  
  *Frangula*, 550  
  *Purshiana*, 543
- Rhamnus Cathartica*, 46, 552
- Rhatany, 442
- Rheum, 27, 293  
  Indicum, 298
- Rheum compactum*, 298  
  *Emodi*, 298  
  *Moorcroftianum*, 298  
  *officinale*, 293, 294, 296, 297  
  *palmatum*, 293, 294, 296, 297  
  *Rhaponticum*, 293, 298  
  *spiciforme*, 298  
  *tanguticum*, 293  
  *undulatum*, 298  
  *Webbianum*, 298
- Rheumatism Root, 210  
  Weed, 677
- Rhizoma Arnicæ, 28  
  Galangæ, 227  
  Podophylli Indici, 351  
  Rhei, 293
- Rhizome and root drugs, 27, 28  
  de podophyllum, 346  
  d'iris varié, 220
- Rhizomes, defined, 24  
  examination of, 25, 26, 27  
  official in N.F., 24  
  in U.S.P., 24
- Rhodophyceæ*, 75
- Rhodymenia palmata*, 76
- Rhubarb, 27, 293  
  Black Hearted, 294  
  Canton, 294  
  Chinese, 293, 298  
  Common Round, 294  
  English, 298  
  European, 298  
  Flats, 294  
  Garden, 298  
  High Dried, 294  
  Himalayan, 298  
  Indian, 298  
  Rhapontic, 298  
  Shensi, 293, 294  
  Turkey, 293
- Rhus chinensis*, 269  
  *diversiloba*, 535  
  *glabra*, 530  
  *radicans*, 533  
  *semialata*, 269  
  *Toxicodendron*, 533  
  *typhina*, 532  
  *venenata*, 533  
  *Vernix*, 533
- Rhus Glabra*, 46, 529
- Riboflavin, 84, 970
- Rice, 159
- Rice Bran, 159, 160  
  Polishings, 45, 52, 159  
  starch, 165, 166
- Richardia indica*, 827
- Richardsonia scabra*, 827
- Ricin, 523
- Ricinus, 47, 521
- Ricinus communis*, 521, 523
- Ricinussamen, 521
- Rinds of fruits, official, 44, 45
- Ringelblumen, 874
- Rocella fuciformis*, 94  
  *Montagnei*, 94  
  *tinctoria*, 94
- Rockberry, 639
- Rocket, 396
- Rockweed Family, 73
- Rocky Mountain Grape, 343
- Roma Chamomile, 870
- Römische Münze, 729
- Rood scorce, 255
- Root barks, 32  
  drugs, 21, 22, 23
- Roots, defined, 21  
  Examination of, 21, 22, 23  
  official in N.F. and U.S.P., 21  
  powdered, 23  
  Tuberous, 23
- Rosa, 41, 404  
  Gallica, 404
- Rosa alba*, 407  
  *centifolia*, 406, 407  
  *damascena*, 407  
  *gallica*, 404, 405, 407
- Rosaceæ*, 404
- Rose, 41, 404  
  Cabbage, 406  
  Damascus, 407  
  French, 404  
  Moss, 406  
  Oil of, 407  
  Otto of, 407

- Rose—(*Continued*)  
 Pale, 406  
 Provins, 404  
 Red, 404  
 rouge, 404  
 Water, Stronger, 407  
 Rose Geranium, 481  
 Rosemary, 719  
   oil of, 722  
 Rosenöl, 407  
 Rosenpaprika, 784  
 Rosin, 51, 117  
   Fig. of, 115  
   oil, 119  
 Rosmarin, 719  
 Rosmarinus, 719  
*Rosmarinus officinalis*, 719, 720, 721  
 Rotenone, 475  
 Rothe Indigo, 94  
   Kleeblumen, 439  
 Rothes Santelholz, 450  
 Rottlera, 50, 528  
 Rottlerin, 529  
 Rubber, 517  
   African, 520  
   Biscuit, 519  
   Borneo, 520  
   Caucho, 520  
   Ceara, 520  
   Crepe, 519  
   Guayule, 520  
   Hard, 519  
   India, 517  
   Pará, 517, 519  
   Plantation, 517, 519  
   South American, 517  
   Vulcanized, 519  
   Wild, 517  
 Rubefacients, 60  
 Rubi Fructus, 416  
   Idæi Fructus, 416  
*Rubiaceæ*, 811  
 Rubus, 30, 415  
   Idæus, 416  
*Rubus allegheniensis*, 415, 416  
   *cuneifolius*, 415  
   *idæus*, 416, 417  
     var. *strigosus*, 416, 417  
   *nigrobaccus*, 415  
   *occidentalis*, 416  
   Section *Eubatus* of, 415  
   *strigosus*, 416, 417  
   *villosus*, 415, 416  
 Ruby Wood, 450  
 Rue, 490  
   and Citrus Family 490  
   de Chèvre, 438  
 Ruellia, 661, 662  
*Ruellia ciliosa*, 661  
 Ruhrwurzel, 822  
 Rumex, 21  
*Rumex acetosella*, 291  
   *alpinus*, 674  
   *crispus*, 21  
   *hymenosepalus*, 298  
   *obtusifolius*, 21  
 Rusbyine, 512  
 Russian Flies, 918  
   Licorice, 428, 431  
 Rusts, in drugs, 14  
*Ruta*, 490  
   *graveolens*, 490  
*Rutaceæ*, 490  
 Rutin, 299, 490  
*Ryania speciosa*, 475  
 Rye, 162  
   Ergot of, 85  
   Spurred, 85
- S**
- Sabadilla, 187  
   dusts, 188  
 Sabal, 168  
 Sabina, 127  
 Sac Fungi, 82  
*Saccharomyces cerevisiæ*, 82  
   Fig. of, 83  
*Saccharomyces Siccum*, 53, 82  
*Saccharomycetaceæ*, 82  
*Saccharum*, 131  
   Lactis, 932  
*Saccharum officinarum*, 131, 132  
 Sacred Bark, 543  
 Safflower, 909  
 Saffron, 213  
   African, 909  
   American, 909  
   Dyer's, 909  
   Meadow, 188  
   Purple, 188  
   Spanish, 213  
   True, 213  
 Saffor, 909  
 Safran, 213  
   des Indes, 229  
 Safrol, 307, 310, 364, 373



- Sage, 34, 741**  
     Dalmatian, 743  
     Garden, 741  
     Greek, 743  
     Indian, 887  
     Meadow, 741  
     Muscatel, 795  
     Spanish, 743  
     True, 741  
 Sagebrush, pollen grain, 65  
**Sago, 176**  
     Pearl, 176  
**Saigon Cassia, 364**  
     Cinnamon, 30, 364  
**Saigonzimmt, 364**  
**St. Ann's Bark, 812**  
**St. George's Herb, 852**  
**St. Ignatius Bean, 665**  
**St. John's Bread, 479**  
**Salbeiblätter, 741**  
*Salicaceæ, 253*  
**Salicin, 254, 255**  
**Saline cathartics, 58**  
**Salix, 254**  
     Leaves, 571  
**Salix alba, 254**  
     *discolor, 255*  
     *fragilis, 255*  
     *nigra, 255*  
     *purpurea, 255*  
**Salmo, 968**  
**Salmonella paratyphi, 989**  
     *Schottmülleri, 989*  
**Salsepareille, 192**  
**Salt Rock Moss, 77**  
**Salvia, 34, 741**  
**Salvia, 706**  
     *lavandulæfolia, 743, 746*  
     *officinalis, 741, 742, 744*  
     *Sclarea, leaves of, 795*  
     *triloba, 743, 746*  
**Sambucus, 41, 836**  
**Sambucus, 836**  
     *canadensis, 836*  
     *nigra, 836*  
**Sammtröse, 404**  
**Sampling, 10**  
**Sandalwood, 285**  
     Australian, 286  
     Family, 285  
     White, 33, 285  
     Yellow, 285  
**Sandelholz, 285**  
**Sanguinaire, 387**  
     Sanguinaria, 24, 387  
     *Sanguinaria canadensis, 387*  
     Sanguinarine, 389  
     Sanguis Draconis, 175  
     Sangsue, 912  
     Santal Citrin, 285  
         Rouge, 450  
     *Santalaceæ, 285*  
     Santalum Album, 33, 285  
         Rubrum, 33, 450  
     *Santalum album, 285*  
     *Santolina chamæcyparissus, 870*  
     Santonica, 42, 885  
         Barbary, 886  
         Santonin-less, 886  
     Santonin, 886  
     *Sapindaceæ, 540*  
     Sapodilla Gum, 646  
     *Sapotaceæ, 645*  
     Sappan, 33  
     Sapwood, 33  
     *Sarcodina, 910*  
     Sarriette, 748  
     Sarsaparilla, 21, 192  
         American, 606  
         Brown, 192  
         Central American, 192, 193, 195, 197  
         Costa Rica, 193  
         distinctions between varieties of,  
             197  
         Ecuadorian, 192, 193, 195, 197  
         Gray, 192  
         Honduras, 192, 193, 195, 197  
         Jamaica, 193  
         Lima, 193  
         Mexican, 192, 193, 194, 195, 197  
         Red, 193  
         Tampico, 192  
         Vera Cruz, 192  
         Virginia, 605, 606  
         Wild, 606  
     Sarsasaponin, 198  
     Sassafras, 30, 362  
         Bark, 362  
         Black, 373  
         Medulla, 33  
         Oil, 364  
     *Sassafras albidum, 362, 364*  
         *variifolium, 362*  
     *Sassafrasrinde, 362*  
     *Satureia hortensis, 748*  
     Sauerdorn, Gemeiner, 343  
     Sauerkirche, 414  
     Saufre végétale, 96

- Sauge, 741  
 Saule blanc, 254  
 Saunders, White, 285  
     Red, 450  
 Savanilla *Krameria*, 442, 444  
 Savin, 127  
     Oil, 127, 128  
     Tops, 127, 128  
 Savory, 748  
     Summer, 748  
 Saw Palmetto, 45, 168  
     Berries, 168  
     Fig. of, 169  
 Saxifrax, 362  
     Pith, 33  
 Scammony, Levant, 21  
     Mexican, 696  
     Root, 21  
 Scarlet Fever Antitoxin, 984  
     Convalescent Serum, 987  
     Streptococcus Toxin, 984  
 Sceau d'Or, 328  
 Schick Test Toxin, 986  
 Schierling, 625  
 Schildkraut, 733  
 Schinopsis, 536  
*Schinopsis Balanæ*, 536  
     *Lorentzii*, 536  
 Schinzent, 607  
 Schlangenwurz, 288  
*Schleichera trijuga*, 917  
 Schlotenpfeffer, 776  
 Schneeballrinde, 837  
*Schoenocaulon officinale*, 187  
 Schwarze Schlangenwurz, 333  
 Schwarzer Pfeffer, 247  
     Senf, 393  
 Schwarzwurz, 701  
 Schweinesschmalz, 934  
 Scilla, 29, 179  
 Scillae bulbosus, 179  
 Scillaren, 181, 182  
 Scille, 179  
 Sclerotium, official, 53  
 Scoke, 303  
 Scoparius, 37, 465  
 Scopalamine, 755, 763, 764, 769, 774  
     Hydrobromide, 774  
 Scopolia, 763  
*Scopolia carniolica*, 758, 763  
 Scotch Broom, 465  
     Thistle, 216  
*Scrophularia*, 784  
*Scrophulariaceæ*, 784  
 Scullcap, 41, 733  
     Mad Dog, 733  
     Marsh, 736  
     Southern, 734  
     Western, 735  
 Scutellaire, 733  
 Scutellaria, 41, 733  
*Scutellaria*, 733, 734  
     *canescens*, 735  
     *cordifolia*, 734  
     *galericulata*, 736  
     *lateriflora*, 733  
     *versicolor*, 734  
 Sea Ash, 499  
     Onion, 179  
     Wrack, 73  
 Sebum Ovillum, 933  
*Secale cereale*, 85, 89  
 Secale Cornutum, 85  
 Sedatives, 60  
 Seed, definition, 47  
 Seeds, albuminous, 47  
     exalbuminous, 47  
     examination of, 48, 49  
     official, 47  
     powdered, 50  
 Seidelbastrinde, 583  
 Seifenrinde, 420  
*Selachoides*, 923  
*Selenicereus*, 579  
     *grandiflorus*, 579  
*Semecarpus Anacardium*, 537  
 Semen Arecæ, 171  
     Cinæ, 885  
     Cydoniæ, 426  
     Fœnigræci, 446  
     Papaveris, 47  
     Pedicularis, 337  
     Theobromatis, 554  
 Semences d'angélique, 623  
     de Coing, 426  
     de Colchique, 191  
     de Lin, 482  
     de Potirons, 856  
     de Psyllium, 802  
     de ricin, 521  
     de Strophanthé, 680  
 Semina Tonco, 444  
 Séné d'Alexandrie, 459  
     de Tinnevely, 459  
 Seneca Snakeroot, 21, 512  
 Senecio, 41, 889, 890  
*Senecio aureus*, 41, 889  
 Senega, 21, 512

Senega—(*Continued*)

- Northern, 513
- Snakeroot, 512
- Southern, 513
- Senegal Gum, 451, 452
- Senegawurzel, 512
- Senfsamen, 390
- Senna, 35, **459** -
  - Alexandria, **459, 462**
  - American, 465
  - Arabian, 461, **465**
  - Bombay, 465
  - Dog, 465
  - Fruit, 465
  - Indian, 459, **462**
  - Maryland, 465
  - Nubia, 459
  - Pods, **462, 465**
  - Sudan, 459
  - Tinnevely, 459, **462**
- Sennæ Fructus, 46, 465
- Sennesbälge, 465
- Sennesblätter, 459
- Sennoside, 464
- Sepia officinalis*, 913
- Sera, official, 54, 55, **986**
- Serenoa, 45, **168**
- Serenoa repens*, 168
  - Fig. of, 169
- Serobacterin, defined, 982
- Serpentaria, 28, **288**
- Serpentary, 25
- Serum Antimeningococcicum, 986
  - Antipneumococcicum, 987
  - Humanum Normale, 939
  - Immune Morbillosi Humanum, 987
  - Immune Scarlatinæ Humanum, 987
  - Meningitis, 986
  - North American Anti-Snake Bite,
    - 927
    - Purified Antidiphtheric, 982
- Sesame Family, 800
  - Oil, 800
  - Seed, 801
- Sesamum indicum*, 800
- Setwall, 28, **852**
- Seven-barks, 28
- Sevum Præparatum, 55, **933**
- Shark Liver Oil, 923
- Shawnee Haw, 843
- Sheepberry, 843
- Shellac, 916
- Shikimmi Fruits, 307
- Shonny Haw, 843
- Short Buchu, 492, 493, 494
- Sialagogues, 60
- Siam Benzoin, 647, 648, 649
- Sierra Leone Pepper, 776
- Silk Sutures, 54
- Silver-feather, 417
- Silver Leaf, 523
  - Poplar, 255
  - Weed, 417
- Simarubaceæ*, 505
- Sinapis Alba, 390
  - Nigra, 393
- Sinapis alba*, 390
- Sitodrepa panicea*, 12
- Skimmianin, 307
- Skullcap, 733
- Skunk Cabbage, 187
- Slippery Elm, 273
- Smallpox Vaccine, 987
- Smilax*, 179, 193
  - aristolochiæfolia*, **193**
  - febrifuga*, 193
  - kerberi*, 193
  - medica*, **193**
  - ornata*, 193
  - Regelii*, **193**
- Snake Weed, 526
- Snakeroot, 288
- Snakeroot, Black, 333
  - Canada, 28, **290**
  - Seneca, 21, **512**
  - Texas, 28, **288**
  - Virginia, 28, **288**
- Snakeweed, 625
- Snowberry, 836
- Soap Bark, 30, **420**
- Soapberry Family, 540
- Soaptree Bark, 420
- Socotrine Aloes, 198, 199, 200, 201, 202,
  - 203
- Sodium Alginate, 72
- Solanaceæ*, 750
- Solanine, 776
- Solanum, 46, **775**
- Solanum carolinense*, 775
  - nigrum*, 763
  - tuberosum*, 23
- Soldier's Shrub, 34
- Solenostemma Argel*, 464
- Somali Myrrh, 508
- Sommerteufelsauge, 340
- Somnifacients, 60
- Sorghum vulgare* var. *saccharatum*, 132
- Sour Cherry, 414

- Southern Black Haw, 837, 841, 843  
   Prickly Ash, 498, **499**  
   Senega, 513  
 Spanish Anise, 610  
   Bugloss, 701  
   Digitalis, 795  
   Ergot, 88  
   Flies, 918  
   Hops, 711  
   Licorice, 428, 430, 431, 432  
   Paprika, 784  
   Psyllium, 803, 804  
   Saffron, 213  
   Sage, 743  
 Spanische Fliegen, 918  
 Sparteine, 467  
   Sulfate, 467  
*Spatholobus Roxburgii*, 475  
 Spearmint, 40, **729**  
 Speedwell, Tall, 798  
 Spelt, 140, 141, 164  
 Sperm Oil, 942  
   Whale, 941  
   Family, 941  
 Spermaceti, 53, 941  
*Spermatophyta*, 106  
 Sphagnum, 95  
*Sphagnum imbricatum*, 95  
   *magellanicum*, 95  
   *palustre*, 95  
   *papillosum*, 95  
 Spigelia, 28, **659**  
*Spigelia marilandica*, 659  
 Spigellie, 659  
 Spigellie du Maryland, 659  
 Spignet Root, 605  
 Spikenard Root, 605  
 Spillbaumrinde, 537  
 Sponges, 911  
 Spores, official, 53  
 Spreading Dogbane, 678  
 Spurge Family, 516  
   Laurel, 583  
 Spurred Rye, 85  
*Squamata*, 927  
 Squaw Mint, 746  
   Root, 344  
 Squill, 29, **179**  
   Male, 182  
   Mediterranean, 29, **179**  
   Red, 180, **182**  
   Spanish, 182  
   White, 179  
 Squirrel Corn, 389  
 Staff Tree Family, 537  
 Stag-bush, 837  
 Staghorn Sumac, 532  
 Staphisagria, 47, **337**  
 Staphisaigre, 337  
 Star Anise, 306  
   Chinese, 306, 307  
   Japanese, 306, 307  
 Star Apple Family, 645  
 Stargrass, 207  
 Starch, 52, **156**  
   arrowroot, 237  
   arum, 238  
   barley, 145  
   cassava, 520  
   corn, 52, **156, 166**  
   manioca, 520  
   maranta, 237  
   oat, 165, **166**  
   potato, 24  
   rice, 165, **166**  
   rye, 165, **166**  
   sago, 176  
   wheat, 142, **166**  
 Starwort, 207  
 Stavesacre, 47, **337**  
 Stechapfel, 764  
 Stem barks, tissue regions of, 32  
 Stems, defined, 37  
   drugs, 37  
   examination of, 37, 38, 39, 40  
   powdered, 40  
 Stephanskörner, 337  
*Stercolepis gigas*, 927  
 Sterculia Gum, 51, **459, 560**  
*Sterculia tragacantha*, 459, 560  
   *urens*, 459, 560  
   *villosa*, 459, 560  
*Sterculiaceæ*, 553  
 Sternanis, 306  
 Sternutatories, 66  
 Stickseed, 700  
 Stigmas, 41  
 Stigmata Maydis, 155  
 Stillingia, 21, **523, 524, 525**  
*Stillingia sylvatica*, 523  
 Stillingie, 523  
 Stimulants, 60, 61  
 Stinkasant, 637  
 Stinking Balm, 746  
   Nightshade, 770  
   Weed, 300  
 Stomach, Diccated Hogs, 934  
   Dried, 934

- Stomachics, 61  
 Stomachus Pulveratus, 54, 934  
 Stomatal Index, 1001  
 Stone Root, 749  
 Storax, 398  
     American, 400, 401  
     Levant, 400, 401  
     Liquid, 398  
 Stramoine, 764  
 Stramonium, 40, 764  
 Strawberry, 404  
     Leaves, 571  
*Streptomyces griseus*, 976, 977  
 Streptomycin, 976  
 Streupulver, 96  
 Striped Alder, 401  
 Strobile, 45  
 Strophanthin, 682, 683  
 Strophanthus, 47, 680  
     Brown, 681  
     Green, 681  
     Seed, 680  
*Strophanthus Courmontii*, 682  
     *Emini*, 683  
     *gratus*, 683  
     *hispidus*, 680, 681, 683  
     *Kombé*, 680, 681, 683  
     *Nicholsonii*, 683  
     *sarmentosus*, 683  
 Strophanthussamen, 680  
 Strychni semen, P.I., 661  
 Strychnine, 664, 667, 668  
     poisoning, 669  
*Strychnos Ignatii*, 666  
     *Nux Vomica*, 661  
 Sturmhut, 314  
 Styptics, 61  
*Styracæ*, 647  
 Styraç, 398  
     liquide, 398  
*Styrax*, 647  
     *Benzoin*, 647  
     *sumatranus*, 648  
     *tonkinensis*, 648  
 Substitution, 4  
 Succus Cerasi, 45, 414  
     Rubi Idæi, 45, 417  
     Thebaicus, 379  
 Sucre, 131  
     de Lait, 932  
 Sucrosum, 52, 131  
 Sudorifics, 58  
 Suet, Mutton, 933  
     Prepared, 55, 933  
 Sugar, 52, 131  
     Beet, 131  
     Cane, 131  
     Maple, 132  
     Milk, 53, 932  
*Suida*, 934  
 Suif de Mouton Purifié, 933  
 Suint de laine, 933  
 Sumac, Berries, 529  
     Climbing, 533  
     Family, 529  
     Scarlet, 529  
     Sleek, 530  
     Staghorn, 532  
     Swamp, 533  
     Tanner's, 719  
     Upland, 530  
     White, 530  
 Sumach, 529  
 Sumatra Benzoin, 647, 648, 649  
 Sumbul, 28, 637  
 Sundew, 41  
 Suprarenal, 945  
 Suprarenalum, 945  
     Desiccated, 945  
     Siccum, 945  
 Surgeon's Agaric, 91  
 Surgical Silk, 53  
*Sus scrofa*, 934, 935  
 Süsse Mandeln, 421  
 Süssholz, 427  
 Sutures, silk, 54  
     sterile silk, 54  
 Swamp Hellebore, 183  
     Sumac, 533  
 Sweating Plant, 887  
 Sweet Almond, 421  
     Oil, 423  
     Balsam, 906  
     Bark, 527  
     Cane, 177  
     Cassava, 520  
     Cherry, 413  
     Cinnamon, 177  
     Cumin, 609  
     Elder, 836  
     Fern, 263  
     Flag, 177  
     Gum, 398  
     Life Everlasting, 906  
     Majoram, 715  
     Marjoram, 715  
     Myrtle, 177  
     Oak, 258

Sweet—(Continued)

- Oil, 650
- Orange Peel, 501
- Potato, 23, 237, 689
- Root, 177
- Wood, 427
- Sweetia panamensis*, 479
- Sweetwood Bark, 527
- Swertia angustifolia*, 676
  - Chirayita*, 675
  - pulchella*, 676
- Sword-fish, 927
- Syconium, 45
- Symphytum, 701
- Symphytum officinale*, 701
  - leaves of, 795
- Symplocarpus fatidus*, 187
- Synonyms, 4, 5
- Synpetalæ*, 639
- Synthetic L. casei factor, 971
- Syrian Alkanet, 701
  - Gum, 457
- Syringa, 649

T

- Tabasco Pepper, 776, 781
- Tacamahac, 255
- Tacca pinnatifida*, 238
- Tachardia lacca*, 916
- Taenifuges, 61
- Talg, 933
- Talka Gum, 454
- Tallow, 933
  - Mutton, 933
- Tallow-bayberry, 258
- Tallow-shrub, 258
- Tamarind, 470
  - Pulp, 470
- Tamarinden, 470
- Tamarindus, 46, 470
- Tamarindus indica*, 470
- Tamarinier, 470
- Tambla Bark, 815
- Tanacetum, 903
- Tanacetum vulgare*, 903
- Tanner's Sumac, 719
- Tannic Acid, 269
- Tansy, 903
  - Wild, 417
- Tapioca, 520
- Tar, 52
  - Coal, 52, 120
  - Juniper, 52, 130

Tar—(Continued)

- Pine, 52, 120
- Wood, 120
- Taraktogenos Kurzii*, 576
- Taraxacin, 895
- Taraxacum, 28, 834, 891, 892
- Taraxacum kok-saghyz*, 520
  - lævigatum*, 891
  - officinale*, 891
- Tarragon, 874
- Tars, defined, 52
  - official, 52
- Tausendgüldenkraut, 674
- Tea, Black, 569
  - Family, 568
  - Green, 569, 570
  - Jerusalem, 300
  - Leaves, 569
  - Pekoe, 570
- Teaberry, oil of, 643
- Teleostomi*, 923
- Teosinte, 151
- Tephrosia, 475
- Tephrosia appolinea*, 464
  - cinerea*, 475
  - latidens*, 475
  - virginiana*, 475
- Térébenthine commune, 113
  - de Venise, 118
- Terebinthina, 52, 113
  - Canadensis, 119
  - Laricis, 118
- Ternstræmiaceæ*, 568
- Terpentin, 113
  - Venetianischer, 118
- Terpentinöl, 116 •
- Terpin Hydrate, 117
- Terra Japonica, 828
  - Silicea Purificata, 52, 70
- Testa Ovi, 929
- Testosterone, 965
  - Propionate, 966
- Testosteroni Propionas, 966
- Tetanus Antitoxin, 984
  - and Gas Gangrene Antitoxins, 984
- Toxoid, 985
- Teufelsdreck, 637
- Texas Snakeroot, 288
- Thallophytes, 69
- Thav, 79
- Thé, 569
- Thea*, 569
  - sinensis*, 569
- Theaceæ*, 568

- Thebaicum, 379  
 Thee, 569  
 Theelin, 960  
 Theelol, 960, 962  
 Theer, 120  
 Theeröl, 120  
 Theine, 571  
*Theobroma*, 553  
     *Cacao*, 554, 556, 557  
 Theobromine, 556  
 Theocalcin, 556  
 Theophylline, 572  
     Ethylenediamine, 572  
 Thiamine Hydrochloride, 970  
 Thierkohle, 969  
 Thornapple, 764  
     Downy, 770  
 Thoroughwort, 887  
 Thousand-leaf, 904  
 Thrombin, 932  
 Thuja, 37, 128  
     Oil, 129  
*Thuja occidentalis*, 128, 129  
 Thujone, 129  
*Thunnus thynnus*, 927  
 Thus, 510  
 Thym, 706  
 Thyme, 706  
     Common, 706  
     Creeping, 711  
     Garden, 706  
     Mother of, 706, 711  
     Oil, 710  
     Wild, 40, 711  
*Thymelæaceæ*, 584  
 Thymian, 706  
     Wilder, 711  
 Thymol, 709, 710  
     Iodide, 710  
 Thymus, 40, 707  
     Serpillum, 40, 711  
*Thymus Serpyllum*, 711, 712  
     *vulgaris*, 707, 708, 710  
     *Zygis*, 710  
 Thyroid, 942  
 Thyroideum, 942  
     Siccum, 942  
 Thyroxin, 945  
 Tickweed, 746  
 Tiglium, 47  
 Tikitiki, 159  
*Tiliaceæ*, 41, 553  
 Timothy, pollen grain of, 63  
*Tinea zea*, 13  
 Tinnevelly Senna, 459, 462  
 Tobacco, 750  
     British, 888  
     Indian, 862  
     Mountain, 875  
     Rabbit, 907  
     Wild, 862  
 Tollkraut, 758  
 Tolu, 51, 437  
     Balsam, 437  
*Toluiifera Balsamum*, 437  
     *Pereiræ*, 436  
 Tonco Bean, 444  
 Tonics, 61  
 Tonka, 242, 444, 445  
     Bean, 444  
 Tonquin Bean, 444  
     Musk, 936  
 Toothache Bark, 498  
     Tree, 498  
 Totaquina, 820  
 Toute épice, 598  
 Toxicodendron, 533  
*Toxicodendron diversilobum*, 533, 535  
     *quercifolium*, 533  
     *radicans*, 533  
     *Vernix*, 533, 534, 535  
 Toxin, defined, 981  
 Toxin-antitoxin, defined, 981  
 Toxinum Diphthericum Detoxicatum,  
     985  
     Diagnosticum, 986  
     Scarlatinæ Streptococcicum, 986  
 Toxoid, defined, 982  
     Diphtheria, 985  
     Tetanus, 985  
 Toxoidum Diphthericum, 985  
     Tetanicum, 985  
*Trachyspermum Ammi*, 710  
 Tragacanth, 456  
     Common, 457  
     Flake, 457  
     Russian, 457  
 "Tragacanth in sorts," 457  
 Tragacantha, 51, 456  
 Trailing Arbutus, 647  
     Mahonia, 343  
 Trichomes, official, 50  
 Trifolium, 42, 439  
*Trifolium pratense*, 42, 439  
*Trigonella Foenum græcum*, 446  
 Trillium, 28  
*Trillium erectum*, 28  
*Tripsacum dactyloides*, 151

Triticum, 27, **132**, 137  
*Triticum æstivum*, 137  
     *dicoccum*, 138, 141  
     var. *dicoccoides*, 138  
     *durum*, 140  
     Ergot of, 90  
     *monococcum*, 141  
     *polonicum*, 140  
     *sativum*, 137  
     *Spelta*, 141  
     *vulgare*, 137  
 Trompillo, 511  
 True Cinnamon, 368  
     Mace, 311, 313  
     Saffron, 213  
     Sage, 741  
     Unicorn Root, 207  
 Trumpet Flower, 656  
*Trutia*, 968  
*Truxillo Coca*, 486, 487  
*Trypeta arnicivora*, 13, 876  
 Tuba Root, 28, **471**  
 Tuberculin, defined, 982  
     Old, 990  
     P.P.D., 990  
     Purified Protein Derivative, 990  
 Tuberculinum Pristinum, 990  
 Tuberos roots, 23  
 Tubers, 23, 24  
 Tulip Poplar, pollen grains of, 63  
 Tuna, 927  
 Turkey Corn, 389  
 Turmeric, **229**, 884  
     Long, 229  
     Powdered, **230**, 885  
     Round, 229  
*Turnera aphrodisiaca*, 34  
     *diffusa*, 34  
*Turneraceæ*, 34  
 Turnip root, 398  
 Turpentine, 52, **110**  
     Alsatian, 119  
     Bordeaux, 116  
     Canada, 119  
     Chios, 536  
     Crude, 113  
     Fig. of, 115  
     Gum, 113  
     Larch, 118  
     Lump, **113**, 116  
     Oil, 116  
     Spirits, 116  
     Venice, 118

Turpentine—(Continued)  
     Wood, 117  
 Turpeth Root, 695  
*Tussilago Farfara*, 888  
 Tussilago Leaves, 888  
 Twin Leaf, 290  
 Twitch Grass, 132  
 Typhoid Combined Vaccine, 988  
     Prophylactic, 988  
 Tyramine, 88  
 Tyrothricin, 978

## U

Uganda Aloes, 203  
*Ulmaceæ*, 273  
 Ulmenrinde, 273  
 Ulmus, 30, 31, **273**  
*Ulmus fulva*, 273  
*Umbelliferae*, 608  
 Umbelliferous fruits, distinction between  
     important, 635  
 Umbrella Plant, 346  
*Uncaria Gambier*, 828  
 Unicorn Root, 28, **207**  
     False, 28, **209**  
     True, 207  
*Uragoga granatensis*, 822  
*Ipecacuanha*, 822  
*Urceola*, 520  
*Urginea indica*, 179  
     *maritima*, 29, **179**, 182  
 Urushiol, 533  
 Uva Ursi, 34, **639**

## V

Vaccina Typhosa et Paratyphosa, 988  
 Vaccine, Antismallpox, 987  
     defined, 982  
     Enteric, 988  
     Jennerian, 987  
     Mixed Enteric, 988  
     Plague, 989  
     Typhoid and Paratyphoid, 988  
     Typhoid Combined, 988  
     Typhus, 989  
     Virus, 987  
     Yellow Fever, 989  
 Vaccines, 987  
 Vaccinum Febris Flavæ, 989  
     Pestis, 989



- Vaccinum—(Continued)  
   Rabies, 988  
   Typhosum, 988  
   Variolæ, 987  
 Valerian, 28, **852**  
   Cat's, 852  
   English, 853  
   European, 856  
   Family, 852  
   Indian, 856  
   Japanese, 855  
*Valeriana mexicana*, 855  
   *officinalis*, 852, **853**, 854  
     var. *angustifolia*, 855  
     var. *latifolia*, 855  
   *Phu*, 855  
   *toluccana*, 855  
   *Wallichii*, 856  
*Valerianaceæ*, 852  
 Valuation of drugs, 8, 9, 10  
 Vandal Root, 852  
 Vanilla, 45, **238**, 240  
   Bean, 238  
   Bourbon, 239  
   Mauritius, 239  
   Mexican, 239  
   Pompona, 243  
   Reunion, 239  
   Splits, 241  
   Tahiti, 238, **239**  
*Vanilla planifolia*, 238  
   *pompona*, 243  
   *tahitensis*, 238  
 Vanille, 238  
 Vanillin, 242  
 Vanillons, 242  
 Vasoconstrictors, 61  
 Vasodilators, 61  
 Vasopressin, 953, 955  
 Vegetable Antimony, 887  
   Gelatin, 79  
   Mercury, 346  
   Sulphur, 96  
 Veilchenwurzels, 216  
 Vein Islet Numbers, 1001  
   Islets, defined, 1001  
 Velvet Dock, 800  
   Leaf, 355  
 Venice Turpentine, 118  
 Venins, Snake, 928  
 Venoms, Snake, 928  
*Vératre vert*, 183  
*Vératrina*, 187  
*Vératrine*, 188  
*Veratrum album*, 187  
   *viride*, **183**, 184, 185, 186  
 Veratrum Viride, 27, 183  
 Verbasci Folia, 34, 800  
   Flores, 41, 800  
*Verbascum*, 784  
   *Blattaria*, 784  
   *phlomoides*, 41, **800**  
   *thapsiforme*, 41, **800**  
   *Thapsus*, 800  
 Verbena, 703  
*Verbena hastata*, **703**, 704  
*Verbenaceæ*, 703  
 Verbenalin, 706  
 Verek, 452  
 Verona Orris, 217, 218  
*Veronica*, 784  
*Veronica*, Tall, 798  
   *virginica*, 798  
*Veronicastrum virginicum*, 798  
 Vertavis, 186  
*Vertebrata*, 922  
 Vervain Family, 703  
 Verveine, 703  
 Vesicants, 61  
*Vetiveria zizanioides*, 168  
 Viburnum, 837  
   *Opulus*, 30, **844**  
   *Prunifolium*, 30, **837**  
*Viburnum alnifolium*, 850, 851, 852  
   *cassinoides*, 843, 844  
   *dentatum*, 844  
   *Lentago*, 843  
   *nudum*, 843  
   *Opulus*, 835  
     var. *americanum*, **844**, 846  
   *prunifolium*, **837**, 838, 840, 841  
     var. *ferrugineum*, 838  
   *rufidulum*, **837**, **838**, 841  
   *trilobum*, **844**, 846  
 Vinettier, 343  
 Viosterol, 84  
   in oil, 85  
*Viperidæ*, 927  
 Virginia Sarsaparilla, 605, **606**  
   Snakeroot, 288  
 Virginische Schlangenwurzels, 288  
 Virus Vaccinicum, 987  
 Viscum, 287  
*Viscum album*, 287  
 Vitamin-A, fat soluble, 142, 151, 925, 926,  
   927, 970  
 Vitamin-B<sub>1</sub>, 84, 142, 147, 151, 161, 925  
 Vitamin-B<sub>2</sub>, 84, 142, 151, **970**

Vitamin-B<sub>6</sub>, 84, 971  
 Vitamin-B Complex, 84, 161, 971  
 Vitamin-C, 84, 781, 969  
 Vitamin-D, 84, 925, 926, 927, 970  
 Vitamin-D<sub>2</sub>, 84, 85  
 Vitamin-D<sub>3</sub>, 85  
 Vitamin-E, 142, 151  
 Vitamin-G, 84  
 Vitamin-K, Synthetic, 970  
 Vitamin-M, 971  
 Vitamins, official, 969  
*Viverra civetta*, 938  
*zibetha*, 938  
*Viverrida*, 938  
*Vouacapoua Araroba*, 470  
 Vulcanite, 519

## W

Wachholderbeeren, 126  
 Wachsmyrte, 258  
 Wafer Ash, 539  
   Bark, 540  
 Wahoo Bark 30: 537, 538  
   llis, T. E., 996, 997  
   lnussrinde, Graue, 263  
   lnut Family, 263  
   White, 263  
   Irat, 941  
   ars, 529  
 Wasserholderrinde, 844  
 Wassertee, 676  
 Water Hemlock, 627  
   Leaf Family, 697  
   Mint, 725  
   Shamrock, 676  
 Watermelon, 856  
 Wax Berry, 258  
   Myrtle, 258  
   Family, 258  
   White Bee's, 921  
   Yellow Bee's 922  
 Waxes, official, 53  
 Weidenrinde, 254  
*Weigela*, 835, 836  
 Weihrauch, 510  
 Weisser Leim, 969  
   Senfsamen, 390  
   Zimmt, 574  
 Weisses Wachs, 521  
 Weizen, 137  
 Wermut, 873  
 West African Gum, 452

## West—(Continued)

Indian Cashew-nut, 536  
   Nutmeg Oil, 313  
   Tamarind, 470  
 Weymouth Pine, 122  
 Wheat, 137  
   Bran, 138, 142  
   Durum, 140  
   Fig. of, 141  
   Flour, 138, 142  
   Germ Oil, 142  
   Germs, 142  
   Histology of, 139, 140  
   Macaroni, 140  
   Middlings, 138  
   Polish, 140  
   Products, 141  
   Spring, 138  
   Starch, 142  
   Winter, 138  
 White Agaric, 91  
   Mint, 725  
   Mustard, 390  
   Oak Bark, 30, 270  
   Pine Bark, 122  
     Figs. of, 123, 124, 125  
   Sumac, 530  
   Walnut, 263  
   Wax, 921  
   Willow, 254  
 Wiesensafran, 188  
 Wild, 852  
   Black Cherry Bark, 407  
   Chamomile, 865  
   Cherry, 407  
     Bark, 30, 407  
   Cotton, 677  
   Geranium, 479  
   Ginger, 290  
   Guelder Rose, 844  
   Hyssop, 703  
   Indigo, 478  
   Lemon, 346  
   Lettuce, 903  
   Licorice, 434  
   Marjoram, 719  
   Mustard, 396  
   Oat, 151  
   Passion Flower, 577  
   Pepper, 583  
   Sarsaparilla, 606  
   Tansy, 417  
   Thyme, 711  
   Tobacco, 862

Wild—(Continued)  
 Wormseed, 300  
 Yam, 25, 210  
 Wildkirchenrinde, 407  
 Willow, 254  
   Bark, 254  
   Black, 254  
   European, 254  
   Family, 253  
   Herb, 571  
   Leaves, 571  
   Poplar Buds, 255  
   White, 254  
 Wind Flower, 342  
 Winter Bloom, 401  
 Wintergreen, 644  
   Bitter, 641  
   Oil, 643, 644  
   Spotted, 643  
 Winter's Bark, 30  
 Wistaria leaves, 571  
 Witch Grass, 132  
   Hazel, 401  
     Bark, 402  
     Family, 398  
     Leaf, 401  
     Water, 404  
 Withe-rod, 843  
 Wolf's Bane, 875  
   Claws, 96  
 Wolfsbane, 314  
 Wollkraut, 800  
 Wood Charcoal, 257  
   Creosote, 271  
   Tar, 120  
 Wood drugs, 33  
   Macroscopic examination of, 34  
   Microscopic examination of, 34  
 Wool Fat, 933  
 Woolfett, 933  
 Worm Grass, 659  
 Wormseed, American, 45, 300  
   Levant, 42  
   Wild, 300  
 Wormwood, 873  
 Wurmfar, 99  
 Wurmsamen, 300, 885  
 Wurstkraut, 715  
 Wurur, 529

## X

*Xanthium italicum*, leaves, 769  
*speciosum*, pollen, 65

*Xanthoxyli Fructus*, 45  
*Xanthoxylum*, 31, 498  
*Xiphias gladius*, 927

## Y

Yam Family, 210  
 Wild, 210  
 Yarrow, 904  
 Yaw Root, 523  
 Yeast, Bottom, 83  
   Brewer's, 82, 84  
   Dried, 53, 82  
   Family, 82  
   Top, 83  
 Yeasts in drugs, 14  
 Yellow Bark, 812  
   Bee's Wax, 922  
   Cinchona, 812, 816  
   Fever Vaccine, 989  
   Gentian Root, 670  
   Immortelle, 884  
   Jasmine, 27, 656  
   Jessamine, 656  
   Mustard, 390, 391, 392  
   Parilla, 351  
   Puccoon, 328  
   Root, 328  
   Wax, 922  
   Wood, 498  
 Yemen Myrrh, 508  
 Yerba Santa, 34, 698  
 Yohimbe, 31, 835  
 Yohimbine, 835  
 Yucca, 179

## Z

Zahnwehrinde, 498  
*Zamia floridana*, 238  
*Zanthoxylum americanum* 45, 498, 500  
   *Clava-Herculis*, 45, 498, 500  
 Zanzibar Aloes, 202  
   Pepper, 776  
 Zauberhasel, 401  
 Zaunrübe, 859  
 Zea, 41, 155  
*Zea Mays*, 132, 151, 156, 158  
 Zedoaria, 25  
 Zedoary, 25, 26  
 Zeitlosenknollen, 188  
 Zeitlosensamen, 191  
 Zeylonzimmet, 368  
 Zibeth, 938

ethum, 938  
Zingiber, 24, 221  
*Zingiber Mioga*, 223  
    *officinale*, 221, 227  
*Zingiberaceæ*, 221  
Zittwersamen, 885  
Zizyphus, 553

*Zizyphus Jujuba*, 553  
Zoological origin, 5  
Zucker, 131  
Zwetsche, 426  
*Zygophyllaceæ*, 489  
Zymase, 83  
Zymine, 935



